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PAPERS

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THE ECONOMIC AND SOCIAL INFLUENCE OF MINING WITH SPECIAL REFERENCE TO THE UNITED STATES.

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INTRODUCTION.

To properly treat this subject would require a large staff of experts; their labors would fill some tens of thousands of pages. In the limited space allowed me I shall mention a few matters that seem interesting and will give some references to publications wherein the desirous student may pursue the subject further.

To make an acceptable definition is not easy: broadly speaking, "Mining" is the extraction of metals, minerals, mineral fuels, ores, and structural materials from the earth. In so far as it works in the earth, mining resembles agriculture, and the relative merits of mining and agriculture have been disputed from time immemorial. Agricola[1]* devotes several pages to this subject and has practically exhausted it; he finds "that mining is not less noble, though far more profitable than agriculture" and that it is a "calling of peculiar dignity". Agricola's remarks are full of classical quotations and are interesting and profitable reading.

Detractors of mining still exist and a writer in a mining

Acknowledgments.—I regret that I have not space enough to give the names of the many persons who have sent me reports and pamphlets and who have in other ways assisted me in the preparation of this article and I herewith express to them my heartfelt thanks for their courtesies.

* The superior figures in the text refer to the numbered references in the appended bibliography.

journal recently took occasion to deny it the name of a basic industry, reserving that term for agriculture. Theoretically, the only basic industry is the procuring of food, and some tropical savages exist without either agriculture or mining; large numbers of nomads live from their flocks and herds without agriculture, but they use iron and so are dependent on mining, and hence mining may be considered more basic than agriculture. But as far as civilized man is concerned, agriculture and mining are equally necessary.

Another opponent of mining, the third vice-president of the Transsiberian railway, told me some years ago that he sincerely hoped no gold mines would be found along the line of his railway, because they attracted a most undesirable population. British administrators of African colonies also combat the opening of mines, fearing the demoralization of the natives through the introduction of liquor and disease.

A favorable view of mining is taken by Professor W. R. Crane, who says:[2]

"Any party of miners producing any given quantity of gold from the earth does more real good to the community than do the business transactions of any similar body of men engaged in any other occupation, because the gold so raised by the miners becomes an immediate addition to the working capital of the country or community, by affording additional means of extending and securing the credit and securing its liabilities".

Statistics.

"The value of the mineral products of the United States now exceeds $2,000,000,000 a year. When compared with the value of the agricultural products this sum, vast as it is, appears relatively small. The value of the corn crop alone in 1913 was $1,692,000,000, more than double the value of the principal mineral product—coal—and the total value of the grains was nearly $2,900,000,000. The marketed products of the barnyard, which include the poultry and dairy products, are estimated to have been worth approximately $1,500,000,000 in 1913. The combined value of the grain, poultry, and dairy products was nearly double that of the entire mineral production".[3]

The following table[4] gives the mineral production of the United States for the year 1909, according to the last census.

Mineral Production of the United States for 1909.

	All enterprises	Producing enterprises	Non-producing enterprises: Number or amount	Non-producing enterprises: Per cent of total
Number of operators	23,664	19,915	3,749	15.8
Number of mines and quarries	27,240	18,164	9,076	33.3
Number of wells	166,448	166,320	128	*
Persons engaged in mining industry	1,166,948	1,139,332	27,616	2.4
Proprietors and firm members, total	33,691	29,922	3,769	11.2
Number performing manual labor	9,937	8,861	1,076	10.8
Salaried employees	46,475	44,127	2,348	5.1
Wage earners	1,086,782	1,065,283	21,499	2.0
Primary horsepower	4,699,910	4,608,253	91,657	2.0
Capital	$3,662,527,064	$3,380,525,841	$282,001,223	7.7
Expenses of operation and development	1,074,191,429	1,042,642,693	31,548,736	2.9
Services	655,584,467	640,167,630	15,416,837	2.4
Salaries	55,878,478	53,393,551	2,484,927	4.4
Wages	599,705,989	586,774,079	12,931,910	2.2
Supplies and material	260,110,898	247,866,304	12,244,594	4.7
Royalties and rent of mines	64,154,926	63,973,585	181,341	0.3
Contract work	30,690,458	28,887,898	1,802,560	5.9
Miscellaneous	63,650,680	61,747,276	1,903,404	3.0
Value of products	$1,238,410,322	$1,238,410,322		

* Less than one-tenth of 1 per cent.

Although the Census distinctly states that it "does not purport to furnish figures which can be used for determining profits or exact cost of production" yet it is worth noting that from the above table can be deduced a profit of $164,218,893 for the year 1909, on a capitalization of $3,662,527,064, or about 4.5 percent—as a large portion of the above capital is fictitious the actual return would be considerably higher.

The total population of the United States in 1909 was 91,972,266: according to the above table, 1,166,948 persons were engaged in mining, or about 1.27 percent of the total population. Special occupational statistics that were also gathered show 38,167,336 persons engaged in gainful occupations; of these 964,824, or about 2.5 percent, were employed in the extraction of minerals.

The Census gives full details of the products for the year 1909, I give here the chief items (see table of "Producing Enterprises 1909"):

I give below some data for comparison; these statistics show that from 1903 to 1913 the value of the minerals produced by the United States increased from $1,489,676,328 to $2,445,805,017, or 64 percent. The other table shows the United States' percentage of the world's production.

Chief Mineral Products of the United States for 1913.[3]

U. S. Geological Survey.

Pig iron, long tons	30,388,935	$ 458,342,345
Silver, troy ounces	66,801,500	40,348,100
Gold, troy ounces	4,299,784	88,884,400
Copper, pounds	1,224,484,098	189,795,035
Lead, short tons	436,430	38,405,830
Zinc, short tons	337,252	37,772,224
Bituminous coal, short tons	478,523,203	565,307,658
Pennsylvania anthracite, short tons	81,718,680	195,181,127
Natural gas		87,846,677
Petroleum, bbl., 42 gals.	248,446,230	237,121,388
Total valuation of all mineral products		$2,445,805.017

Chief Mineral Products of the United States for 1903.

U. S. Geological Survey.

Pig iron, long tons	18,009,252	$ 344,350,000
Silver, troy ounces	54,300,000	29,322,000
Gold, troy ounces	3,560,000	73,591,700

Producing Enterprises 1909.

Industry	No. of operators	Wage earners Dec. 15th or nearest representative day		Value of products	
		Number	Per cent	Amount	Per cent
All industries	19,915	1,065,283	100.0	$1,238,410,322	100.0
Coal	3,695	743,293	69.8	577,142,935	46.6
Petroleum and natural gas	7,793	39,831	3.7	185,416,684	15.0
Copper	161	53,143	5.0	134,616,987	10.9
Iron ore	176	52,230	4.9	106,947,082	8.6
Precious metals	2,282	37,815	3.6	94,123,180	7.6
Lead and zinc	977	21,603	2.0	31,363,094	2.5
Structural materials	3,988	92,350	8.7	75,992,908	6.1
Miscellaneous	843	25,018	2.4	32,807,452	2.7

Copper, pounds	698,044,517	91,506,006
Lead, short tons	282,000	23,520,000
Zinc	159,219	16,717,995
Bituminous coal, short tons	282,749,348	351,687,933
Pennsylvania anthracite, short tons	66,613,454	152,036,448
Natural gas		35,807,860
Petroleum, bbl., 42 gals.	100,461,337	94,694,050
Total valuation of all mineral products		$1,489,676,328

Comparison of the Chief Mineral Products of the United States and of the World.

U. S Geological Survey.

	Year	World production	Year	U. S. production	U. S. per cent
Coal, short tons (various years)[5]		1,443,393,052	1913	570,048,125[5]	39.5
Petroleum, bbl. of 42 gals.	1913	381,508,916	1913	248,446,230	65.1
Copper, pounds	1913	2,198,732,130	1913	1,224,484,098	55.6
Pig iron, metric tons	1912	72,566,084	1912	30,966,152	42.7
Gold, dollars	1912	$466,136,100	1912	$93,451,500	20.0
Silver, troy ounces	1912[5]	224,310,654	1912	63,766,800	28.4
Lead, short tons	1912	1,282,513	1912	392,517	30.6
Zinc, short tons	1912	1,070,045	1912	338,806	31.7

The tendency of the mining industry of the United States to fall into the hands of powerful corporations is well shown in the 13th Census:[4] 11,384, or 57.2 percent, of the 19,915 operators produce less than $5000 each, and less than 1.5 percent of the total value; while 164 operators produce more than $1,000,000 each and 92.7 percent of the copper, 84.2 percent of the iron ore, and 84.2 percent of the anthracite coal; these 164 operators, though less than one percent of the total number, produced 57.5 percent of the total value.

Bureau of Mines.

The splendid work of the Bureau of Mines deserves a special article; I have only space enough to briefly mention some of its activities. It was established in July, 1910, and its powers enlarged by another act in February, 1913; four annual reports[6] and about 200 bulletins and technical papers have been issued, all of which are of great value to the mining industry and to which reference is made for a fuller account of the work of the Bureau. Its chief work, up to June 30th, 1914, the date of the

last annual report, has been the investigation of problems having to do with the causes and prevention of coal-mine explosions and with the safeguarding of the lives of coal miners. In addition, work has been done on the testing of coal and other mineral fuels belonging to or for use of the Government of the United States. During the fiscal year ending June 30, 1914, investigations were undertaken looking to greater safety and the prevention of waste in the metal-mining and miscellaneous industries of the country. Recently work has been done in an examination of several oil and gas fields of the country with a view to eliminating the large waste of natural gas in these fields. The establishment of this Bureau of Mines has been of great benefit to the mining industry, and its beneficial influence is sure to increase in the years to come. As pointed out in the Fourth Annual Report, the amount of money devoted to mining by the United States Government is ridiculously small and it is to be hoped that future Congresses may be more liberal.

CHARACTERISTICS OF MINING.

The foregoing pages give some notion of the economic importance of mining and I will now give a brief outline of its characteristics, take a cursory glance at its history, touch on the racial changes among mining employees, accidents, strikes, unions, and the probable future of the industry.

The most prominent feature of mining is its destructiveness. The farmer, by use of manures and nitrogen-fixing plants can look forward to countless generations of fertile fields; the scientific forester may count on an equally permanent yield from his woodlands; the fisherman need never fear that the sea will refuse its harvest; but the miner looks forward to the day when all mineral deposits shall be exhausted. This, happily, will not be in the immediate future, and, judging by the record of such mines as Rio Tinto in Spain, and Laurium in Greece, which have been worked intermittently for some 3000 years, some of the mines now working will last several centuries at least. But, nevertheless, the prophetic eye of the conservationist sees the day when all our mineral wealth shall be no more. I will give some details on this subject later.

A second characteristic of mining is its failure to reward

honest and intelligent effort. For large amounts of capital, expended under the direction of skilful engineers, mining offers a certainty of profit, but for the man of small means there is a strong probability of loss; superhuman efforts of brain and muscle will avail nothing, unless attended by good fortune. This risk is so well understood that mining is more and more passing into the hands of powerful financiers who extend their operations over the whole world.

Gold mining presents the peculiarity of being the only business whose product has an unlimited free market at a fixed price. The gold miner does not have to consult a market report to find out what ore will pay a profit, nor is he obliged to hunt for a buyer; the doors of the Mint are open for him during business hours and his gold bullion is always salable at the fixed price of $20.67 per ounce of pure gold.

Mines are so often found in the desert that it is fair to say that another peculiarity of mining is the providing of a desert community with water, food, and shelter[7] and providing the mines with supplies. The sanitation of such a town is often a matter of great difficulty. Epidemics frequently attack these mining camps; I mention the pneumonia of Bodie and the unusual "black pneumonia" of the early days of Tonopah.

The social problems arising in isolated mining communities —especially in foreign lands—are difficult of solution and a source of worry to the mine manager. Col. Goethals had to deal with a problem of this sort and seems to have found the regulations of the living conditions of the gold and silver employees almost as troublesome as the engineering problems of the Panama Canal.[8]

What puts mining in a class by itself is the enormous profits that have been made by prospectors, operators, and speculators; the history of mining is full of accounts of such great fortunes. The Comstock Lode, of Nevada, is responsible for four ultra-millionaires, and recently Tonopah and Goldfield have enriched many. A remarkable case was that of six citizens of Adelaide, South Australia, whose investment of $250 each in the Kalgoorlie mines grew to $7,500,000 in four years:[9] the original purchasers of Mount Morgan and of Broken Hill also received enormous returns for their original investments. It

would be tedious to enumerate the great fortunes made in nearly every one of the Western States by miners: I mention Stratton, Walsh in Colorado; Hearst in several States, Hayward and Hobart in California and Clark in Montana. Of world-wide fame is the petroleum-based Rockefeller fortune. In mining speculation great fortunes have been made—and lost; in late years the advance of the Consolidated Virginia, in 1886, from 10 cents to $50 and of Mohawk, in 1907, from less than 20 cents to over $20 are the sharpest advances that I recall; it is these large profits that cause mining shares to sell far above their dividend-value.

Fraudulent Mine Promotions.

By using these great profits as a lure, fraudulent promoters have robbed the public of vast sums—in the process a very few of the more reckless promoters have encountered the heavy hand of the United States postal authorities and have landed in jail. Their methods have been to advertise extensively in the press and to send out millions of circulars; these circulars contained the prospectus of a mining company and were often works of great literary merit. Their general argument was that mining is the most profitable business known and that while three quarters of all merchants fail there is almost no known instance of a gold mine failing to pay large profits; they point out the great fortunes made from the investment of a few dollars in the shares of some noted mine and show how much better the chance is nowadays, when modern mining and metallurgical science enable us to make immense profits from ore deposits that were formerly valueless. The prospectus-writer skilfully ranges from the riches of Ophir and the tribute of the Queen of Sheba to Jim Butler's wandering mule that led his owner to the phenomenal riches of Tonopah.

No statistics are available as to the money secured by these methods, but in the boom year of 1906 they must have run into the scores of millions; I know of one of these companies whose receipts for a long period averaged over $100,000 daily—all paid in for shares of worthless mines. In 1906 there was a veritable mania for speculating in mining shares, comparable to the tulip and South Sea Bubble crazes of former days and to the London rubber boom of 1910. The West Australia excitement of 1896

was another time of wild mining speculation; the public was so hungry for shares that the promoters could not acquire properties and form companies fast enough to supply the demand; in one case a company was formed before any mine had been bought and £100,000 of shares sold to the public, who purchased the shares on representations, made in the prospectus, that a valuable mine had already been acquired; a mine was bought afterwards—naturally, it proved worthless.

To give an adequate account of the fraudulent representations of mine owners and the "salting" of their ores would require a special treatise.[10]

Litigation.

Another characteristic—in Western metal mines, at least—is the never-ending litigation largely due to the apex law,[12] a law by which the miner is allowed to follow his ore in depth outside the ground situated vertically below his surface claims. On the Comstock Lode alone, $10,000,000 was spent in these lawsuits prior to 1866[11]; the total cost for the whole mining region must amount to an appalling sum.

The apex law, because of the complex geological features accompanying ore deposits, has given rise to a series of problems that the human intellect cannot solve and most mining engineers are anxious to see it replaced by a law confining miners to vertical boundaries.

Besides being plagued by apex lawsuits, miners are frequently troubled by farmers who allege that their fields are ruined by debris from the mines, or smoke from the smelters; this last injury is said to have given rise to the "smoke-farmer", whose most profitable crop is the damages that he receives from the smelter.

Anti-debris litigation took a serious form in California about 1880 and by 1887 had closed down nearly all the hydraulic mines. The average annual production for the years 1880-1882 was $17,500,000; for the years 1890-1892 the average was $12,366,666, thus showing an actual diminution of production of $5,133,334. Well-informed mining men, however, consider that as hydraulic mining was developing rapidly at the time the litigation started, the probable loss in production is fully $10,000,000 annually.

CHARACTERISTICS OF THE MINER.

Turning from the characteristics of the mining industry to those of the miner himself we find that his most prominent characteristic is audacity or recklessness in the face of danger. Dealing with dynamite that blows him into fragments and working under treacherous roofs that send him to eternity without warning breeds in him a contempt for death. His spirit is well shown in the remark of the Cornish miner who fell from the surface into the 1300-foot Imperial shaft of the Comstock lode; he was saved by grasping the bell-rope 20 feet down. When rescued he turned to his friends and said: "By the bloody 'ell, if I hadn't caught hold of the bob, I'd a been scattered all abroad".[11]

It is said that the safety-first movement is making miners less reckless, and this is borne out by statistics of accidents in Butte. On studying the death-rate of coal mines[13] from 1896 to 1914—the only statistics that I have at hand—I find the death-rates are for the first three years: 1896, 2.84; 1897, 2.53; 1898, 2.72. For the last three years the figures are: 1912, 3.15; 1913, 3.73; 1914, 3.30. The averages are: 1896-1905, 3.19; 1905-1914, 3.73.[13] These statistics show no improvement as yet, but it is probable that in the long run the safety-first movement will have a marked influence for good.

The bravery of the miner shows to best advantage in mine rescue work, when to save his comrades he dares deadly gases and caving galleries. Open any mine accident report and you will find instances of his daring—often to his own undoing. In the last Pennsylvania report[14] I find: "The tragic aspect of this disaster is accentuated by the fact that while only two men were killed by the original explosion, eighteen others, including the superintendent, the foreman, nine rescuers and seven tunnel men, were killed by a second explosion caused by the tunnel men igniting the gas released by the fall of a stump pillar following the first slight explosion".

The warm-hearted generosity of the miner equals that of the sailor and his starvation in the caved mine parallels that of the shipwrecked sailor on his raft: in one point there is a difference—I believe that cannibalism is unknown in the mine annals. With regard to the miner's character I quote from

Roberts:[15] "Elements of sympathy, tender feeling and kindness are to be found among no class of workmen to a greater extent than among miners".

I have said above that the miner has a contempt for death; sometimes it seems as if he has an equal contempt for property rights; for from the experience of the Goldfield Consolidated some years ago it seemed as if many of the miners were of the opinion that no one had a better right to rich gold specimens than the miner who found them and that it was mere sophistry on the part of the mine bosses to say that the gold must be turned over to the company.

A FEW NOTES ON THE HISTORY OF MINING.

Mining probably began with our cave-dwelling ancestors' search for pebbles to throw or to use as hammers; such stone hammers are found in abundance at the ancient copper mines of Lake Superior and are still in use among savages. The most primitive mining recorded was at Brandon, England,[16] where in search for flint 254 shafts, many of which communicate, were sunk from 20 to 60 feet deep by means of deer horns.

Trade developed through this primitive mining; something of its extent is seen in the distribution of native copper, from Lake Superior, over North America and of bronze swords of identical character from Russia to Ireland.

But little is known as to the date of this early mining, but it is probably later than Egyptian mining, of which records go back to 4000 B. C.

Something of the horrors of Egyptian mining have come to us in the oft-quoted passage from Diodorus Siculus, which he quotes from Agatharchides, a Greek geographer of the 2nd century, B. C. "In the confines of Egypt and the neighboring countries of Arabia and Ethiopia there is a place full of rich gold mines out of which with much cost and pains of many laborers gold is dug. * * * For the Kings of Egypt condemn to these mines notorious criminals, captives taken in war, persons sometimes falsely accused, or against whom the King is incensed * * * There are infinite numbers upon these accounts thrust down into these mines, all bound in fetters,

where they work continually, without being admitted any rest night or day, and so strictly guarded that there is no possibility or way left to make an escape. For they set over them barbarians, soldiers of various and strange languages, so that it is not possible to corrupt any of the guard by discoursing one with another or by the gaining insinuations of familiar converse. * * * No care at all is taken of the bodies of these poor creatures, so that they have not a rag so much as to cover their nakedness, and no man that sees them can choose but commiserate their sad and deplorable condition, for though they are sick, maimed, or lame, no rest or intermission in the least is allowed them; neither the weakness of old age, nor woman's infirmities are any plea to excuse them; but all are driven to their work with blows and cudgelling, till at length overborne with the intolerable weight of their misery, they drop down dead in the midst of their insufferable labors; so that these miserable creatures always expect the future to be more terrible than even the present, and therefore long for death as far more desirable than life. * * * And, therefore, I cannot but conclude that nature itself teaches us, that as gold is got with labor and toil, so it is kept with difficulty; it creates everywhere the greatest cares; and the use of it is mingled both with pleasure and sorrow''.[1]

Mining began in China many years ago; the most available record is the Shoo King:[17] this gives some information regarding minerals in about 2200 B. C. ''Strange stones'' were found in the famous Tai Shan Mountain, in Shantung; the maritime Province of Yang Chou at the mouth of the Yangtzekiang produced gold, silver, and copper, as well as ''yao k'un'', said by one commentator to be ''beautiful gems'', and by another described more cautiously as ''fine stones inferior to gems''. The Province of Ching-chou, in Hupei, produced as tribute gold, silver, and copper, as well as grindstones, whetstones, arrowhead stones, and cinnabar. From Liangchou, which extended over parts of the present Provinces of Shensi, Szechuan, and Yunnan, came jade, iron, gold, silver, and copper: it is noted by commentators that in the time of the Han Dynasty (206 B. C. to 14 A. D.) the State had organized iron-works in the Province of Liangchou under official superintendents entitled ''t'ieh

kuan'', ''iron officers''. Two of these early captains of industry, named Cho and Ch'ing, amassed such large fortunes that they were ''deemed equal to princes''.

The Scythians, whose tumuli in Siberia contain beautiful golden ornaments, the unknown inhabitants of Mashonaland, the Greeks, and the Romans were extensive miners. The mines of Laurium were the economic mainstay of Athens for the three centuries during which the State had the ascendency in Greece. Many hundreds of shafts were sunk by the Greeks and the vast piles of slag, left by the ancient smelters, have provided profitable occupation to a French company for many years. According to Strabo, the Romans had 40,000 mines in Spain alone.[18]

It is worth while to point out here that modern machinery and technical knowledge are often powerless to make a profit from mineral deposits that were worked by the ancients and many a company has come to grief by assuming that ancient miners did not understand their business.

The discovery of America brought about a marked change in mining industry by pouring vast stores of gold and silver into Europe; the hope of finding rich mines was one of the great stimulants to early explorers, and in Mexico and Peru they found their hopes realized. The ransom paid by Atahualpa, Inca of Peru, when held prisoner by the Spaniards for the blasphemous crime of striking a Bible from the hands of a fanatical priest, gives some idea of the quantity of gold in that country.[19] Atahualpa filled a room 17 by 22 feet to the height of a man with singing birds, ears of maize, and other ornaments, all wrought in pure gold—their value has been estimated at $20,000,000. A similar hoard of art objects, valued at $7,500,000, was found in Mexico.[20]

The discovery of these hoards led to active mining on the part of the Spaniards with most disastrous results to the natives, who were forced to labor in the mines and died by the scores of thousands. Even to this day, the population of Peru is far less than in the times of the Incas—their terraced fields are barren wastes and their well-kept roads but a memory.

For a description of early mining and of mining in the middle ages there is nothing to compare with Hoovers' transla-

tion of Agricola[1] to which I refer for further details on this interesting subject.

The next important step in the history of mining, after the discovery of America, was the invention of the steam engine; it is worth remembering that its first practical use was in pumping from coal mines. Mining developed rapidly with the development of steam power (1760 to 1830), and was given a great impetus by the discovery of gold in California (1848). A voluminous literature has grown up about the Pioneers of '49;[21] this is not the place to rhapsodize on their wonderful qualities; I will content myself with remarking that I have known many of them and have a great admiration for their energy, resourcefulness, perseverance, and generosity. Perhaps it is well to say that not more than one in ten made more than good wages. The discovery of gold in Australia soon followed that of California; for big nuggets and recklessness Australia holds the record; no California nugget equals the "Welcome Stranger"[22] of Ballarat, nor does any Californian recklessness equal the champagne baths of the lucky Australian "digger".

More important than the discovery of gold has been the development of the great iron-ore deposits of Michigan and Minnesota and the opening of the coal mines of this country. I shall say nothing of petroleum, which deserves a special volume and whose romances and extravagancies—remember Coal Oil Johnny—are not surpassed by anything in the history of gold mining. Within the last twenty years the most startling incidents in mining history have been the opening of the vast bodies of low-grade copper ores, the "porphyry mines" and the great low-grade gold mines of Alaska. The Transvaal, which has far outstripped the United States in gold production, deserves more than this scanty mention.

RACES AND RACIAL CHANGES IN MINES DUE TO IMMIGRATION.

I confine myself to the changes that have taken place in a few of our mines and their effects on our social organization. I refer the inquirer to the reports of the Immigration Commission,[23] which was established February 20, 1907, and completed its work by Christmas, 1909, at an expense of $790,000; its publications already amount to 41 volumes of more than 30,000

pages, a portion of which deal with the mining industry. Much of what follows is taken from these reports.

Prior to 1870 the labor in our mines was almost entirely American, British, and a few Germans. Since about 1880 the English-speaking miners in the coal, iron, and copper mines of the United States have been largely replaced by immigrants from Southern and Eastern Europe; in the opinion of many scientists this change has already been detrimental and is full of danger for the future of our country. The immigration prior to 1883 was mainly from Great Britain, Belgium, Denmark, France, Germany, Holland, Norway, Sweden, and Switzerland and is termed the ''old immigration''; it furnished 95 percent of the Europeans coming to this country before 1883. The ''new immigration'' comes from Southern and Eastern Europe and consists chiefly of Bohemians, Bulgarians, Croatians, Finns, Greeks, Italians, Lithuanians, Magyars, Montenegrins, Poles, Portuguese, Roumanians, Russians, Ruthenians, Servians, Slovaks, Slovenians, Syrians, and Turks; all of these races are found in our mines.[25, 26] There has also been a vast immigration of Russian and Polish Jews; they do not work in the mines, and in a racial classification of over 50,000 mine employes I have found only one Jew listed.

The desirability of the different races as workmen was investigated by the Immigration Commission; statements were obtained from a number of mine managers. The consensus of opinion among the mine managers of Michigan was that the Scotch and Scandinavians were perhaps the best and that all the ''old immigration'' was satisfactory. The so-called ''black races''—the Croatians, Greeks, Montenegrins, and South Italians are the least desirable, mainly because of their poor physique, partly due to the fact that they do not eat enough, and are, therefore, unable to do the hard work of the ''white miners''. The Finns, excellent workers, are bull-headed, troublesome and ready to take advantage of the company when labor is scarce; those who have been in the country for some time are steadier and less truculent than the younger Finns who are apt to be socialistic and anarchistic agitators of the worst type. This same complaint was made of the Finns in the Lake Superior copper strike and the managers are said to be replac-

ing them by other races when possible. It is to be said for the Finns that they become permanent citizens, while the Austrians and South Italians go back to Europe when they have made a "stake". The hard-drinking habits of the Finns and Slovenians are said to cause many accidents.

After 1883 the "new immigration" amounted to more than 50 percent and by 1907 had reached 81 percent, as shown in the following table:[27]

	Year		Per cent	
	1882	1907		
Old immigration	563,175	227,851	86.9	19.0
New immigration	84,937	971,608	13.1	81.0
Not specified	38	107		
Total	648,186	1,199,566	100.0	100.0

The result in the anthracite mines of Pennsylvania is given below.[28]

Races in the Anthracite Mines of Pennsylvania.

	1870	1880	1890	1900	1910
Total foreign born	108,000	109,000	171,000	194,000	267,000
Slav and Italian	306	1,925	43,000	89,000	178,000
English-speaking	105,000	103,000	124,000	100,000	82,000

* * * * * * * * * * * *

Note.—The writing of this paper was completed in June, 1915, and when presented at the meeting of the International Engineering Congress, in September, 1915, it contained statistics, drawn chiefly from volume 16 of the Immigration Commission Reports, which seemed to show that the pay of the anthracite miners in Pennsylvania was less than the amount required for physically efficient living. These statistics were claimed to be erroneous by the Anthracite Section of the American Institute of Mining Engineers, and the Section asked that they be omitted. The same request was also made by the American Institute of Mining Engineers.

In view of the fact that since the paper was written the wages of the anthracite miners have been materially increased and their hours of labor reduced to eight, daily, and therefore their living conditions have been improved, and, furthermore, in order to avoid controversy in the transactions of this Congress, the author has consented to omit these statistics and his remarks, indicated by asterisks on this and subsequent pages, relating to the anthracite miners' wages. This step is taken by the author in deference to the request of the Committee of Management of the Congress and without prejudice to his own views in the matter.

The beginning of this racial movement in Pennsylvania is said to have been the importation, by Eckley B. Coxe, to Drifton, in 1870, of a large number of Hungarians. In 1876, Lithuanians and Poles arrived and about 1883 came Ruthenians, Slovaks and Syrians; the Italians came later, about 1890.[29] Belgians, however, were imported into Belleville, Ohio, in 1863, during a strike, and Bohemians and Italians were brought to Braidwood, Illinois, to take the place of strikers in 1866.

In the iron mines of Michigan, the earliest miners were Cornish, next came Finns, then Scandinavians, Hungarians, North Italians, Poles; in 1907, 31 races were represented in these mines. In Negaunee, Michigan, iron mining began in 1844; at Marquette and in Ishpeming in 1849, when the miners were Cornish, Irish, and Americans; in 1870, French Canadians came as laborers and teamsters, but they have never become miners; other races came—Swedes, 1874; Finns, 1883; Italians, 1887. The British immigration was from 1856 to 1885; in 1876 they began to leave for Menominee and in 1884 for Gogebic and later for the mines of Montana, Colorado, and Nevada. Since 1883 the British element has decreased. Finns first came in 1883 and are now more than any other race—15 percent in 1905.

The Immigration Commission did not study any of the Western metal mines and racial statistics are hard to obtain.

Judging from the mining town of Grass Valley, it seems as if there has been less racial change in Californian mines than in other sections, for the sons of the miners follow their fathers' occupation, which is unusual in the eastern mines.[30] The early miners in Grass Valley, where mining began about 1852, were Cornish and Irish and practically all the present employes are English-speaking.

The annexed table shows the racial composition by place of birth of a number of mining employes. The percentage of Americans varies from 5.6 in both the bituminous "Community A"[24] of the Immigration Commission and in the iron mines of Michigan to 54.4 at the Goldfield Consolidated in Nevada and 68.0 in a Comstock mine, also in Nevada, in 1914. The English-speaking miners are a minimum of 7.5 percent in the same "Community A" and a maximum, 93 percent, in the Comstock mines in 1880. The "old immigration" shows 72 percent in the

Michigan iron mines in 1898, while it is but 46.44 percent in the same mines in 1909; the least (3.9) percent is in the same "Community A" in 1909.

The "new immigration" varies from 1.7 percent in the Comstock mines, 1880, to 90.5 percent in "Community A." It is evident that the racial composition of the Nevada mine employes depends largely on the manager of the mine, for the Goldfield Consolidated has 54.4 percent of Americans, while in the Tonopah mines, only twenty miles away, the percentages for two of the larger mines are 31.9 and 26.1;[31] this indicates a surplus of idle miners, and the change in the Homestake mine, South Dakota, from 72 percent of foreign miners in 1909 to 29 percent in 1914 supports this indication.[32]

Living Conditions of the Miner.

The annual earning of some miners is shown in the following table:

Coal Mines.	Average yearly earnings	Daily average
Colorado.		
The Colorado Fuel & Iron Co.[33]	$ 999.36	$4.02
Rocky Mountain Fuel Co.[33]	1,007.01	4.36
Victor-American Fuel Co.[33]	1,100.75	4.01
Indiana.		
Block-coal hand mines[34]	499.61	
Block-coal machine mines[34]	458.84	
Bituminous hand mines[34]	727.42	
Bituminous machine mines[34]	737.27	
General average for all mine employes[34]	736.06	
Pennsylvania.		
* * * * * * * * * * * * * *		
Michigan.		
Copper Mines.		
Heads of families native-born[23]	847	
Heads of families foreign-born[23]	737	
Iron Mines.		
Heads of families native-born[23]	1,024	
Heads of families foreign-born[23]	674	
All heads of families[23]	706	
Croatians[23]	534	

In the Michigan copper mines the average wage of all miners is[35] $3.47 daily; 2.54 percent earn $5 or more and 0.31

percent earn \$2.50 or less. In the Nevada mines wages are from \$3 to \$4 daily; the latter wage has been paid in the Comstock mines for many years.

The table shows that the foreign-born earn less than the native-born; as a result the foreign-born have a lower standard of living. The Immigration Commission's reports give a vast amount of detail about living conditions.[23] For example: In the iron mines the native-born of native-father-family consists of 4.27 persons to the apartment, with 0.97 persons per room, 2.41 persons per sleeping-room; the rent is \$1.38 per person, while the Croatian has a family of 10.42 persons per apartment, with 2.79 per room and 4.45 per sleeping-room and pays \$0.67 rent per person per month.

The maximum number of persons per room greatly exceeds the above average; an instance is given of a Ruthenian family with wife, two children, and seven boarders in one room;[36] also 24 foreigners in one room 15 by 18 ft. Eighty-two percent of the Croatians add to their income by taking an average of 7.32 boarders, or lodgers per family, while the average for the native-born is but 0.59 persons for 18 percent of the families. For the native-born family the father's pay provides 96.8 percent of the income, but for the Croatian the father brings in but 39.0 percent; of the balance, 57.2 percent comes from boarders and lodgers and 3.4 from the children.

Special investigators of the cost of living have found that in the Borough of Manhattan[37] (New York) "\$825 is sufficient for the average family of 5 individuals, comprising the father, mother and 3 children under 14 years of age to maintain a fairly proper standard of living". In Buffalo, New York, the cost is estimated at \$755, and in Johnstown, Penna., the estimate is \$780.[38]

* * * * * * * * * * * * * *

The great change in the condition of the laborer is perhaps best seen in the millhands of Lowell; in the fifties these were practically all Americans, living plainly but well, the social equals of their employers. The Sunday parades of handsome young women, each with her parasol, are mentioned by admiring European visitors. Now the employes live, crowded thirty at a time, in houses built for a family of six[39] and the days when

Benjamin Franklin thought of "the happiness in New England, where every man is a freeholder, has a vote in public affairs, lives in a tidy warm house, has plenty of good food and fuel" have long since passed away.[40, 97]

Increase of Population in the United States.

Our Fourth of July orators paint in rosy colors the marvellous progress of this country and point to its rapid increase of population as something for which we should be supremely happy and as an index of our superiority to other nations. But on this basis the Russian can consider his the greater country, for her population has increased in actual numbers much more rapidly than has that of the United States.

If it can be proved that our great increase in population has been accompanied by a disproportionate increase in poverty and misery we ought to regard the increase as a disgrace, rather than a source of rejoicing. I have found no statistics that enable me to come to any final conclusion on this point, but many facts indicate that, considering our great increase in wealth, poverty has not decreased as it should have done; an illuminating fact is that in our largest and richest city—New York—in 1914, out of the 74,803 persons who died, 7868 were buried in a pauper's grave;[41] this certainly shows an enormous amount of suffering and an extremely unsatisfactory state of society. Most of the members of the Immigration Commission decided that a considerable portion of the misery in this country is due to the large immigration, especially the "new immigration", and feel that the time has come for restricting immigration. This seems also to be the sentiment of the country, for three bills restricting immigration have been passed by Congress, all three, however, have been vetoed—by Cleveland, Taft, and Wilson. In each case the bill failed, by a very few votes, to overcome the veto.

The discussions in Congress over these bills are of extreme interest, but too voluminous to detail here. I will, however, call attention to one argument in favor of restricting immigration that does not seem to have been brought out in recent congressional debates: this argument is, that by admitting immigrants with a lower standard of living we decrease the birth-rate of our own people, and that population would

have increased as rapidly, during the last century, without immigration. In this connection it is interesting to note that Elkanah Watson, in 1815, made a calculation of the future population of the United States, based on the natural increase from the loins of the people then living;[40] his figures agree remarkably well with the actual population up to 1860, when he predicted 31,753,824—the actual population was 31,443,321. The Civil War caused a slight lessening of our increase: Watson's estimate for 1900 was 100,235,985, while the census for 1909 gave 91,972,266, and we have only just reached 100,000,000 in 1915.

Among the many believers in the theory that immigration has not increased our population, I mention Francis A. Walker, superintendent of the 9th and 10th Censuses, president of the American Statistical Society from 1882 to 1897, and formerly president of the Massachusetts Institute of Technology. His views are given in the following quotation: "Between 1850 and 1870 the rate of increase in the native population of the United States fell sharply off, and between 1870 and 1890 the decline was accelerated. As foreigners came the native population withheld their increase. The access of foreigners, at the time and under the circumstances, constituted a shock to the principle of population among the native element. That principle is always sensitive alike to sentimental and economic conditions. The decline occurred by singular correspondence with the excess of foreign arrivals but chiefly also in those regions to which the newcomers most freely resorted".[39]

The general sentiment of the country is so strongly in favor of restricting immigration that it is highly probable some restrictive legislation will be enacted in the near future. But even without legislation it seems likely that immigration will be greatly curtailed within the next century or two, at farthest, and that the rate of increase of our population will materially decline. With regard to this increase, it may interest the arithmetically-minded to point out that population cannot long continue to increase at the rate for the period 1900-1910 (the last for which we have accurate information and in which the rate was 21 percent) for if it did so continue to increase, then, by the year 2500 there would be a population so large that each

person would only have about twelve square feet to move about in.

ACCIDENTS IN MINES; SAFETY-FIRST MOVEMENT; WELFARE WORK; WORKMEN'S COMPENSATION ACT.

Accidents.

Mining is an extra-hazardous occupation. The rate charged for accident insurance on miners by California was 7.86 percent of the payroll, thus being a little more than five times the rate on agricultural laborers—1.50 percent. I remark in passing that in addition to the greater liability to accident the miner is afflicted with special diseases: nystagmus, an eye disease, causing temporary or permanent blindness; ankylostomiasis, or miner's anemia; silicosis, or consumption; and lead poisoning.[44]

The following table shows fatalities in recent years in both coal and metal mines.[13, 45, 46] It will be noticed that there are several methods of reporting these fatalities; the fairest method is the reduction to a 300-day year; on this basis the metal mines have a slightly lower death-rate for the years given. France and Belgium also employ this 300-day year in their coal-mine statistics, and a comparison with these countries shows the United States in a very unfavorable light; for the decade 1901-1910 the averages were: United States death-rate, 5.26 per 1000 employed; France 1.76, Belgium 1.04; or taking the United States rate as 1000, the deaths in France were 335 and in Belgium 198. When it is considered that coal-mining conditions in the United States are usually less dangerous than in Europe, this heavy death-rate is disgracefully high. The French death-rate for 1906 was 7.83; this abnormally high rate was due to the most disastrous mine accident ever known, that at Courrieres, in which 1099 miners were killed; replacing this rate by the average of the other years of the decade, France's average for 1901-1910 becomes 1.09 per 1000 employed, or 207 if the United States fatalities are taken as 1000.

The death rate in foreign metal mines is in almost every case lower than that of the United States, the only marked exception being in Tasmania, where, in 1912, a fire in which many lives were lost raised the rate to 9.52.

Number of Men Employed and Number Killed in and about all Mines in the United States.

Year	Number employed	Number killed	Number killed per 1,000 employed	Number killed per 300-day year	Number killed per million short tons of coal	Number of short tons of coal mined per death
Metal mines						
1911	165,979	695	4.19			
1912	169,199	661	3.91	4.09		
1913	193,088	683	3.54	3.72		
1914						
Average for 1911-1912-1913	176,089	680	3.86			
Coal mines						
1911	728,348	2,719	3.73	5.09	5.48	182,501
1912	722,662	2,360	3.27	4.35	4.41	226,469
1913	747,644	2,785	3.73	4.70	4.89	204,685
1914 (subject to revision)	742,868	2,451	3.30		4.81	208,878
Average for 1911-1912-1913	732,885	2,621	3.58			

The following table shows the relation between the death rate of the Rand and of the United States for the last three years.

Fatalities per 1000 Employes in the Metal Mines of the United States and in the Witwatersrand Gold Mines.[46] [47]

Year	Witwatersrand.						United States death rate per 1000
	Number killed		Death rate per 1000		Death rate per 1000		
	White	Colored	White	Colored	Total		
1911	91	789	3.68	4.15	880	4.10	4.19
1912	54	791	2.26	4.10	845	3.90	3.91
1913	72	718	3.11	3.89	790	3.81	3.54
					Average	3.93	3.88

The above table shows that for the years 1911 and 1912 the death rate for the Rand was somewhat lower and in the year 1913 considerably higher than that of the United States. Altho the Rand average death rate for the three years given in the table is higher than that of the United States, yet taking into consideration the fact that more than seven-eighths of the employes are Kaffirs it appears as if the United States rate is far too high.

To the question: Why is the death rate in the United States so much higher than it is in Europe? I think that the answer is: greater carelessness. It is, however, stated that the higher rate of the United States is due to the presence of a large percentage of foreign-born laborers in our mines who do not understand English and who, altho they work as miners, are not familiar with mining work. In 1897, however, the chief inspector of mines for Pennsylvania considered these men no more liable to accident than the English-speaking miner.[23]

The following reasons were given for the excessive number of accidents in Michigan iron mines: lax discipline, countenance of intoxication, absence of law forbidding the employment of green hands, carelessness and recklessness of men.[23] In his report for 1913, James E. Roderick, Chief of Department of Mines for Pennsylvania, classes the fatalities as in the following table:[14]

Classification of Fatalities.

Report of the Department of Mines, Pennsylvania, 1913.

	Number killed	Death due to carelessness of deceased Per cent	Death due to carelessness of others Per cent	Unavoidable accident Per cent	Responsibility not defined	Per cent total
Anthracite mines	557	65.35	6.28	28.37	....	100.00
Bituminous mines	561	57.93	1.96	22.64	17.47	100.00
Total	1,118	Average 61.6	4.10	25.5	8.8	100.00

This table shows that very nearly two thirds of the deaths are due to carelessness. In Great Falls, Montana, it is found that about 85 percent of the accidents are likewise due to carelessness.[48] The Inspector of Mines for Montana reports that "The great danger lies in the acts of ignorant and irresponsible laborers and miners who take unnecessary risks in defiance of law and common sense * * * the only way to keep them from menacing the lives of the entire underground force is to keep them continually under competent supervision. It is only by a rigid system of discipline that any approach to safety can be guaranteed in mines where death and disaster may follow an apparently insignificant act of thoughtlessness".[49]

Intoxication is one of the causes of accidents in mines, and a good example of its working was recently seen in Butte, Montana, where the accident record of the Anaconda Copper Mining Company shows the following significant figures:[48]

Number of Accidents per 10,000 Shifts:

1914	
July	6.22
August	11.25
September	4.21
October	7.58
November	6.07

"*** from Sept. 1 to Sept. 14, all saloons were closed; ** from Sept. 14 to Sept. 24 they were open only from 8 a.m. to 7 p.m., and * for the balance of the month they were open only from 7 a.m. to 10 p.m." It will be noted that the accidents dropped from 11.25 per 10,000 shifts in August to 4.21 in September, when the saloons were wholly or partially closed and rose to 7.58 in October when they were open.

The following table shows the mine accidents classified by ability to understand English.

Employes in Anthracite Community A. Pennsylvania.[23]

Race	Number	Per cent	Accidents No.	Accidents Per cent	Accidents per 100
English-speaking.					
Americans	7,645	25.0	155	31.0	2.0
English	1,375	4.5	11	2.2	0.8
Irish	3,836	12.5	23	4.6	0.6
Scotch	185	0.6	1	0.2	0.5
Welsh	728	2.4	5	1.0	0.7
German	2,722	8.8	27	5.4	1.0
	16,491	53.8	222	44.4	1.35
Non-English-speaking.					
Lithuanian	5,519	18.0	75	15.0	1.4
Polish	4.426	14.0	139	28.0	3.1
Slovak and Ruthenian	2,892	9.4	31	6.0	1.1
Italian	1,223	4.0	23	4.6	1.9
Other races	250	0.8	8	2.0	3.2
	14,310	46.2	276	55.6	1.93
Totals	30,801	100.0	498	100.0	1.62

The above table shows that the accidents are about 20 per-cent lower among the English-speaking miners and thus bears out the contention that our high accident rate is due, in part at least, to the presence of non-English-speaking foreigners in our mines.

The following table shows a comparison of the causes of death in the coal and metal mines of the United States.

Percentage of Deaths Due to Stated Causes in the Mines of the United States.

	Coal mines [13]	Metal mines [50]
	Per cent	Per cent
Fall of overhead material	48.77	32.40
Haulage accidents	15.34	5.29
Falling down chute, winze, raise or stope	....	6.50
Gas explosions	6.95	....
Coal-dust explosions	1.27	....
Explosions of coal-dust and gas together	4.53	....
Explosives	5.64	11.04
Electricity (shock or burns)	3.22	2.87
Shaft accidents	2.29	15.13
Killed on surface	7.92	8.93
Killed on surface where surface mining is done	....	12.10
Other causes underground	4.07	5.74
	100.00	100.00

In the various States the rate of accidents varies enormously from year to year. The maximum death rate for the period 1896 to 1911 was 159.79 in Utah, in 1907, with an output of 5000 tons of coal per fatality; the minimum death rate per 1000 employes being in Montana, in 1899, 0.42 per 1000, with an output of 1,496,000 tons.[13]

Safety-First, Welfare Work, Industrial Service Movements.

From these murderous figures it is refreshing to turn to a consideration of a number of movements that seem certain to greatly diminish the accident rate in our mines in the future. While all honest mine managers have ever held the safety of their men above all else, yet the Safety-First Movement, in its present definite form, seems to have started quite recently, and the earliest mention that I have seen of its use is in the Pennsylvanian mines of the H. C. Frick Coke Co. in 1907.[51] In these mines very elaborate precautions are taken, and the record for 1914 per 1000 employes, 1.46, is very low. The United States Coal & Coke Co. of West Virginia has used great precautions and has also employed special assistant foremen whose business it is to remain in any dangerous working place until the dan-

gerous conditions are removed; a bonus is paid for the fewest accidents. The average number of men under one of these "safety-first foremen" is 22. Since 1909, when the work was first started, the number of tons produced per fatality has risen from 107,323 to 428,962 (to November 1, 1914) for both inside and outside fatalities, and for the inside fatalities alone the tons have risen from 128,788 to 571,949.

Among the many companies that have taken hold of this safety-first movement is the Anaconda Copper Mining Company, where it is under charge of C. W. Goodale. This company publishes a monthly magazine, "The Anode", that is entirely devoted to safety-first. Mr. Goodale states that "comparing 1914 with 1913 I will say that we have reduced the fatal accidents 35 percent on the basis of 10,000 shifts, and the serious accidents 26 percent. In the case of the minor accidents, we have not been so successful—we have only reduced them about 3 percent".[48]

The Bureau of Mines is also doing much work on these lines and is finding moving pictures very useful—as are other operators. I regret that I have not more space to give further details of this admirable work that will save much suffering and many lives in the future.

Welfare Work goes hand in hand with safety-first and aims to improve the living conditions of the men and to provide for health, education, and recreation. To this end large sums are being spent by mining companies all over the country; space is lacking to more than summarize the activities of one company. I select the Homestake of South Dakota: this company spends on its Hospital Service and Aid Association $65,000 yearly; supports a staff of seven doctors and six nurses; the hospital treated 1109 surgical cases in 1913, all free of cost to its employees and their families; a safety-first movement was started in 1913 and reduced the number of accidents about 32 percent in the first quarter of 1914.[32] The company subscribes $200 to each of 16 churches or $3200 annually. Mrs. Hearst, who is the largest shareholder, provides a library and a free kindergarten. A $300,000 theater has been built, and there is a special recreation department.

An interesting variety of welfare-work is the Industrial

Service Movement, which is bringing together the engineer and the industrial worker, so that the workers may be educated and the educated men may learn how to work: the work is based on fraternity and teaches foreigners English and citizenship, gives lectures to English-speaking workmen, forms clubs for mental and moral improvement.[52] During 1914, 3500 students from 200 colleges have been regularly engaged in teaching more than 60,000 workmen, and 3000 graduates are active in industrial betterment as a result of the work that they did while undergraduates. The Industrial Service works thru local bodies; the Y. M. C. A. alone has put 8000 branches at the service of the engineers who are interested in the work.

While this welfare and social service work is sometimes regarded with suspicion by the miner, who is apt to think that it "is done to prevent strikes and to keep down labor troubles and labor unionism", yet its benefits are keenly appreciated and "perhaps one of the greatest benefits welfare work accomplishes is its tendency to level class interests, to promote comradeship".[53]

Workmen's Compensation Acts.

The safety-first and social welfare movements aim to make the miner's life more worth living and to protect him against accident. But, in spite of all human care, accidents arrive to the most careful of miners under the best of managements. In the past it was considered that the workman's extra risk was fully covered by higher wages, but that theory has been abandoned in favor of a more humane system, by which the loss due to the accident is not wholly borne by the individual sufferer but is, in part, transferred to the industry in which he was employed. This system—The Workmen's Compensation—began in Germany in 1884 and is now in force in various European countries.[54] The United States Government passed the law in 1908 and New York State enacted a similar law in 1910 and was followed in 1911 by Ohio, Washington, Massachusetts, New Jersey, Wisconsin, California, Kansas, Illinois, Nevada, and New Hampshire, and by the end of 1915 at least 28 States will have protected their workmen by like laws.

There is too great a variety in the laws passed by these many States to allow of detailed description, but in several the

compensation is provided by a fund into which each employer pays a certain fixed percentage of his payroll, the exact amount depending on the nature of his business.[54, 58] In Ohio this rate is adjusted every six months in such a way that the employer who has the least accidents pays the smallest rate; for example, in machine shops with $100,000 annual payroll the premiums paid varied from $600 to $825 annually.

In some States the insurance in the State fund is compulsory, but in most the employer is allowed to insure with the regular insurance companies or, if financially able, he may carry his own insurance. In several States the employer may remain outside of the act if he wishes, but in this case he is deprived of the usual common-law defenses in actions for damages for personal injuries brought against him by his injured employes.

The Montana law goes into effect July 1, 1915,[57] and as this law passed after prolonged consideration and discussion of the laws of many other States it practically embodies the good features of the previous legislation. In the Montana law there are three plans: payment into a fund by tax on payroll; direct payment to the employe by the employer who furnishes satisfactory proof of his financial ability; insurance in approved companies that are permitted to do business in Montana.

The passage of these Workmen's Compensation Acts was violently resisted by damage-suit lawyers, who saw loss in fees and rake-offs; by large corporations, who saw ruin from excessive payments to injured workmen; and by insurance companies, who feared loss in premiums. In a number of States the acts were fought on the ground that they deprived the employer of his property without due process of law and, hence, were contrary to the 14th Amendment to the Federal Constitution, and the act as first passed in New York was declared unconstitutional; later a constitutional amendment was passed and the act is now in force in that State. Workmen's Compensation laws have also been passed on by the courts of last resort of Massachusetts, Ohio, and Wisconsin, and by the U. S. Supreme Court, and have been upheld in every case: constitutional amendments have been passed by California and Ohio (as well as New York), so it is pretty plain that the Workmen's Compensation Laws have come to stay.

Number and Race of Mining Emoloyes.

		"A"		"B"		"C"		"D"		"E"		"F"		"G"		"H"		"I"		"J"		"K"		"L"	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1	English speaking																								
2	Native born Native father	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	104	3.4	148	2.6
3	" " Foreign "	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	66	2.2	935	16.6
4	Total Americans	396	31.2	318	54.4	337	45.5	770	27.8	137	68.0	4505	36.29	811	23.15	62	5.6	122	6.4	7645	25.0	170	5.6	1083	19.2
5	Australians	-	-	16	2.7	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	Canadians	7	.6	3	.5	6	.8	232	8.4	-	-	586	4.72	9	.25	-	-	-	-	-	-	-	-	77	1.4
6a	Canadian French	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	293	5.2
7	English	28	2.2	77	13.2	60	8.1	640	23.1	18	9.0	1683	13.56	163	4.64	275	25.0	256	13.5	1375	4.5	25	.8	831	14.8
8	Irish	19	1.5	58	10.0	3	.4	816	29.5	14	7.0	2398	19.34	62	1.76	67	6.1	63	3.3	3836	12.5	11	.3	40	.7
9	Scotch	54	4.2	7	1.2	12	1.6	83	3.0	3	1.5	127	1.02	155	4.42	8	.7	17	.9	185	.6	11	.3	14	.2
10	Welch	-	-	5	1.0	34	4.6	34	1.2	3	1.5	161	1.28	33	.93	-	-	-	-	728	2.4	14	.5	3	.1
11	Total British	108	8.5	166	28.6	115	15.6	1806	65.2	38	19.0	4995	39.92	422	12.00	350	31.8	336	17.7	6124	20.0	61	1.9	965	17.2
12	Total English-speaking	504	39.7	484	83.0	452	61.0	2576	93.0	175	87.0	9460	76.21	1233	35.15	412	37.4	458	24.1	13769	45.0	231	7.5	2048	36.4
13	Belgians	63	5.0	1	.1	-	-	2	.1	-	-	-	-	-	-	-	-	19	1.01	-	-	-	-	3	.1
14	Danish	4	.2	6	1.0	-	-	16	.6	-	-	28	.22	8	.22	-	-	20	1.03	-	-	-	-	3	.1
15	Dutch	-	-	-	-	3	.4	2	.1	-	-	15	.14	2	.05	-	-	-	-	-	-	-	-	1	
16	French	1	.1	4	.7	2	.3	17	.6	-	-	12	.11	51	1.45	86	7.8	112	5.9	-	-	7	.2	2	
17	Germans	21	1.6	7	1.1	27	3.6	67	2.4	4	2.0	160	1.28	56	1.59	6	.5	25	1.3	2722	8.8	35	1.2	114	2.0
18	Norwegians	73	5.7	32	5.5	-	-	6	.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	41	.7
19	Swedish	93	7.4	7	1.2	-	-	22	.8	3	1.5	-	-	-	-	-	-	-	-	-	-	18	.6	108	1.9
20	Scandinavians	-	-	-	-	88	11.9	-	-	-	-	397	3.22	163	4.64	351	31.9	371	19.5	-	-	-	-	-	-
21	Swiss	-	-	-	-	-	-	12	.4	-	-	18	.17	7	.20	-	-	-	-	-	-	-	-	8	.1
22	Total "Old" Immigration	363	28.5	223	38.2	235	31.7	1950	70.4	45	22.5	5585	45.06	709	20.15	793	72.0	883	46.44	8846	28.8	121	3.9	1538	27.3
23	Austrians	179	14.1	-	-	124	16.7	-	-	2	1.0	902	7.26	904	25.65	-	-	39	2.07	-	-	-	-	15	.3
24	Bohemians	3	.2	-	-	-	-	12	.4	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-
25	Bulgarian	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
26	Bulgarians and Reumanians	-	-	-	-	-	-	-	-	-	-	24	.19	26	.74	-	-	-	-	-	-	-	-	-	-
27	Croatians	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	.5	499	8.9
28	Finns	62	4.9	14	2.4	34	4.6	1	-	-	-	653	5.26	468	13.34	187	17.0	473	24.9	-	-	-	-	1530	27.1
29	Greeks	62	4.9	4	.7	-	-	-	-	-	-	4	.03	4	.11	-	-	-	-	-	-	1	-	-	-
30	North Italians	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	166	5.5	542	9.6
31	South Italians	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	146	4.9	57	1.0
32	Italians	90	7.1	14	2.4	11	1.5	14	.5	17	8.5	405	3.26	409	11.55	58	5.3	340	17.9	1223	4.0	-	-	-	-
33	Lithuanians	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5519	18.0	38	1.3	40	.7
34	Magyars	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	940	31.3	84	1.5
35	Montenegrins	21	1.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	.23	-	-	-	-	-	-
36	Montenegrins and Servians	-	-	-	-	-	-	-	-	-	-	222	1.78	96	2.73	-	-	-	-	-	-	-	-	-	-
37	Poles	-	-	-	-	-	-	19	.7	-	-	1	.01	37	1.03	-	-	27	1.43	4426	14.0	588	19.5	66	1.2
38	Portuguese	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	.1
39	Roumanians	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28	.9	2	-
40	Russians	40	3.1	-	-	-	-	2	.1	-	-	43	.34	31	.88	-	-	-	-	-	-	55	1.8	5	.1
41	Ruthenians and Slovaks	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2892	9.4	-	-	-	-
42	Servians	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	.1
43	Slavonians	-	-	8	1.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44	Slovaks	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	743	24.7	2	-
45	Slovenians	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	.1	158	2.8
46	Syrians	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
47	Turks	2	.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48	Total "New" Immigration	459	36.1	40	6.9	169	22.8	48	1.7	19	9.5	2254	18.13	1975	56.03	245	22.3	895	47.16	14310	46.2	2724	90.5	3011	53.5
49	North American Indians	25	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50	Japanese	28	2.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51	Jews	-	-	1	.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
52	Mexicans	-	-	2	.3	-	-	2	.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
53	Spaniards	-	-	-	-	-	-	-	-	-	-	3	.02	1	.02	-	-	-	-	-	-	-	-	-	-
54	Other Races	-	-	-	-	-	-	-	-	-	-	64	.50	23	.65	-	-	12	.63	250	.8	-	-	-	-
	Total	1271	100.0	584	100.0	741	100.0	2770	100.0	201	100.0	12411	100.00	3519	100.00	1100	99.9	1900	100.00	30801	100.0	3015	100.0	5632	100.0

"A" Alaska Treadwell Mines. December 31, 1914. Letter from F. W. Bradley.

"B" Goldfield Consolidated Mg. Co. June 1914. Letter from A. J. Stinson, Inspector of Mines for Nevada.

"C" Bunker Hill and Sullivan Mines. June 1914. Idaho. From F. W. Bradley.

"D" Comstock Mines, Nevada. 1880. Comstock Mining and Miners, Eliot Lord. Washington 1883.

"E" Comstock Mines. June 1914. Letter from A. J. Stinson.

"F" Butte Mines. Report of Department of Labor and Industry. State of Montana. 1913-1914.

"G" Coal miners in Montana. Report of Department of Labor and Industry. State of Montana. 1913-1914.

"H" Iron miners in Michigan in 1898. Immigration Commission. Parts 17-20. 1910. 61st Congress 2nd sess., Sen. Doc. No. 633. On back vol. 78. Serial No. 5677. page 411.

"I" Iron miners in Michigan in 1909. Immigration Commission. Parts 17-20. 1910. 61st Congress 2nd sess., Sen. Doc. No. 633. On back vol. 78. Serial number 5677. page 411.

"J" Anthracite Coal Miners. 1909. Community A. Penna. Sen. Doc. Serial No. 5677, see reference "H". page 665.

"K" Bituminous coal miners. 1909. Community A. Penna. Immigration Commission. Parts 1 and 2. 1910. 61st Cong. 2nd sess., Sen. Doc. 633. On back vol. 68. page 482.

"L" Copper miners in Michigan. 1909. Sen. Doc. No. 633. Serial No. 5677. See reference "H".

Before the passage of these acts, various companies insured workmen against accident, and when an accident happened the victim frequently found himself obliged to bring an action at law to recover his just dues; if he won the suit his lawyer took a large portion of the amount recovered and if the victim settled directly with the insurance company he was put off as long as possible and a minimum payment made him in the end; for example, a Nevada miner who lost both legs was paid a few hundred dollars after long delay. Ten companies in New York from 1906-1908 received $23,524,000 in premiums and paid out $8,560,000, or about 36.3 percent for benefits.[54] In Nevada during the first eighteen months of the act the benefits paid and arranged for amounted to 84.3 percent of the premiums.[55] In Ohio the losses paid will amount to about 81 percent of the premiums and the experience in other States shows that over 80 percent will be paid out.

In the percentage of claims paid there is a marked difference between the operation of the insurance companies under the old system and the State under the present acts.[54] For example: the Aetna Insurance Company in its Cleveland, Ohio, agency showed that in the eight years preceding 1910 it paid 6 percent out of 65,800 claims presented for injuries and deaths, while the remaining 94 percent received nothing. In contrast with this the Industrial Commission of Ohio, during the six months ending June 30, 1914, dealt with 26,463 cases of which 95.9 percent were allowed and 1128, or 4.1 percent, rejected.

The compensation for fatal cases also showed a marked difference; in 370 fatal cases settled in court by insurance companies the average award was $949.19, of which the lawyers must have taken a considerable portion; while the average total amount allowed by the Ohio Industrial Commission in 142 fatal cases was $2752.29.[54] The time required for settling the fatal cases averaged one month and four days under the Ohio Commission; while under the old system in the Common Pleas Court 25 months were required. It is of interest to note some of the actual amounts paid for death benefits: the first family to receive death benefits in Cleveland, Ohio, was awarded $3400, payable in bi-weekly installments at the rate of $12 per week; medical and funeral expenses were paid in addition: in Nevada

the widow of a miner who was killed by a falling rock is to receive $5000, payable in one hundred monthly installments of $50 each; funeral expenses of $125 were also paid.[55]

The Workmen's Compensation Act is so new and local conditions vary so in the many States that there is great difference in the percentage charged on the payroll; but allowing for all this, there still seems an unreasonably large variation; for example, taking the Wisconsin rate at 100, the New York rate is 86, and the Ohio rate 30 for not markedly different benefits.[54] The death compensation varies from $2500 in Colorado to $5000 in California and Nevada. The maximum payment will occur under a permanent total disability; this sum is limited in a number of States, but not in California, where, under specially unfavorable circumstances, a single loss might require the setting aside of a sum of over $10,000.[43]

In none of the State reports relating to the Workmen's Compensation Acts have I found any reference to self-injurers and malingerers, those parasites that will surely appear. The length to which a man will go to avoid hard work is almost inconceivable; perhaps the limit was that laborer who premeditately sat down on an English railway track and allowed the train to cut off both his legs; unfortunately for him, when the case was tried in court his premeditation was revealed and he recovered no damages. Curious cases constantly come up before the compensation boards: a stenographer, while taking dictation from her employer, was killed by a jealous suitor—decided that she lost her life in the course of her employment and a death benefit was paid her heirs; the same decision was made in the case of one who, while working, was stabbed by a fellow-employe. On the other hand, compensation was denied an employe, employed to operate a truck, who stopped work and pursued a rat, which ran down an elevator shaft; while looking down the shaft the employe was injured by a descending elevator. Held: that the injury was not sustained in the course of employment. In Germany compensation was denied one who was going to church to pray for rain and when injured en route claimed to be engaged in agriculture.

To summarize: as compared with the former system the result of the Workmen's Compensation Act is that a much

larger portion of the money paid in as premiums is paid out as benefits; there is much less delay in paying the benefit; there is no disposition to avoid paying compensation that ought to be paid. It seems probable that most of the benefits will be paid by that unfortunate person—the ultimate consumer—but, in so far as the act takes money from those who have more and gives it to those who have less, it is probably working for the benefit of society, it is, however, but a small factor in establishing the socialistic millenium.

UNIONS.

United Mine Workers of America.

The United Mine Workers of America—the most powerful mining union in the United States—is composed entirely of coal-mine employees; it has been active in most coal-mine strikes since 1890 and claims to have greatly improved the condition of the miners in the mines that it has succeeded in unionizing.[72]

Its popularity in Pennsylvania has given rise to "button" strikes; several took place in 1913.[14] A strike of this kind has for its cause the objection raised by some of the employees to the employment of men who do not wear the button of the United Mine Workers. "In some cases the failure of even one man to wear the button has precipitated a strike".

The membership of the United Mine Workers increased from 20,912, in 1890, to 289,269, in 1912, and in December, 1913, it was 415,142.[53] The financial statement for 1913 showed: income, $2,159,031.69; expenditure, $2,102,261.44; balance on hand, $278,032.30. In addition to this sum, the local organizations have over $3,000,000 in cash, "every dollar of which can be used for defensive purposes". But the funds of the United Mine Workers are used aggressively as well as defensively, and in unionizing Paint Creek, West Virginia, they are said to have spent $300,000 and in the Colorado strike of 1913-1914 the amount expended is variously estimated at from $1,000,000 to $3,044,000.[73]

I have read the Proceedings of the 24th Convention of the United Mine Workers, held in Indianapolis, Indiana, January 20 to February 3, 1914, and while a number of members advocate violent measures and denounce the capitalists in good set

terms, the bulk of the speakers show no disposition to overturn our present social system.[53] The main objects of the union are: the obtaining of more pay, shorter hours, and better working conditions; to these ends the unionizing of all the coal-mines of the United States and of Canada is being attempted. Though the members of the union theoretically believe in peaceful measures, yet they do not hesitate to resort to violence when thought necessary.

Various views are held with regard to this union, for example, Professor John R. Commons states "that large coal operators assert that they can carry on their business to better advantage than without it"; this is also the testimony of other scientists thoroughly familiar with the situation in various coal-fields.[74] On the other hand, the independent mine operators of Colorado, producing between 60 and 70 per cent of the total coal produced in Colorado, and in whose companies neither John D. Rockefeller, nor John D. Rockefeller, Jr., nor any controlling stockholder in the directory or officer in the Colorado Fuel and Iron Company has any interest—these mine operators state: The United Mine Workers "by force of numbers, by its control of labor, and by virtue of the millions of dollars forcibly collected from its members, has become so powerful that its leaders are now defying organized society to thwart its plan to rule or ruin.

"By their criminal acts the leaders of the United Mine Workers of America have forfeited any claim that organization may have ever had to be considered a labor union, and have foreclosed any right it may have ever possessed as a pretended labor union to demand that we have business dealings with it".[33]

The Reverend A. A. Berle, for some years professor of applied Christianity at Tufts', now president of the New England Civics Institute Colleges, and interested in practical labor legislation for some 20 years, studied the Colorado coal strike during a 10-day visit in 1913; he speaks of the United Mine Workers as a "group of men who seek, with irresponsible and unlimited funds, to supply arms and ammunition to ignorant men and urge them to commence a bloody assault upon the laws and orderly administration of public affairs".[75]

The courts of West Virginia decided that the United Mine Workers is an illegal organization; this decision was upheld by higher courts.[53] A special commissioner, who investigated conditions on Vancouver Island reported to the Dominion Government "that the United Mine Workers of America is a disorderly, illegal mob that has absolutely no respect for law and order or anything that has any semblance of decency".[53]

Demands of Miners.

At the 24th Convention of the United Mine Workers of America 534 resolutions were offered by the local unions and 56 amendments to the constitution were proposed; although many of these resolutions were not adopted by the convention, yet it is of interest to note what is being asked, since it is likely that mine operators will be obliged to grant some of these demands in the future.[53]

Probably the most often repeated demand is for a reduction of hours of labor, without any reduction in wages; on the ground that there is a surplus of labor and that this is the best way of giving employment to more men; these demands range from a seven-hour day, seven-hour day from bank to bank, seven-hour day with full pay for Saturday half-holiday, to a six-hour day; this last being asked by many of the resolutions. To meet the over-production of coal, demands are made for a five-day week at six hours daily. Increase of wages is repeatedly asked for; the resolution offered by the Virginville, West Virginia, local union, that the minimum wages paid be, "$5.00 per day for the machine men and $4.50 per day for any inside worker and $3.75 for outside day labor, six hours to constitute a day's work", is the maximum demand that I have noticed; by many locals, pay is requested for work now done gratis by the miner. Other demands are: companies shall be required to give bonds guaranteeing payment of sums due workmen; a weekly pay day not later than 1 p. m. on Saturdays; payment by run-of-mine and not by screened coal; right to test weighing-scales; free coal for household use; reduction of rents; union-made blasting powder of standard quality; miners not to work in mines shipping coal into strike districts, or in mines using machinery from "unfair" factories; sons of miners to be employed if fathers so desire; entire abolition of electricity in

mines owing to danger of explosions and accidents from live wires (within a few minutes after writing this I read, in the San Francisco "Chronicle" of May 31, 1915, of the death of Joseph Jones, 24 years old, in a mine at Copperopolis, California; reaching for the bell cord he grasped the power-wire instead and was electrocuted); an oft-repeated demand is that men shall be hired in turn as they apply for work, regardless of creed, color, or nationality, or activity in union matters.

Western Federation of Miners.

This union, organized in Butte, Montana, May 15, 1893, operates chiefly in the metal mines west of the Mississippi River;[76] "it is not the policy of the Federation to announce how many members it has enrolled", but there is probably "a membership of approximately 40,000, in good standing, and something like 200 locals".[49]

The preamble of the constitution of the Western Federation states: "We hold that there is class struggle in society, and that this struggle is caused by economic conditions. We affirm the economic condition of the producer to be that he is exploited of the wealth which he produces, being allowed to retain barely sufficient for his elementary necessities. We hold that the class struggle will continue until the producer is recognized as the sole master of his product. We assert the working class and it alone, can and must achieve its own emancipation. We hold, finally, that an industrial union and the concerted political action of all wage workers is the only means of attaining this end. Therefore, we wage slaves employed in and around the mines, mills and smelters of the world, have associated in the Western Federation of Miners".[76]

This preamble indicates that the Federation does not believe in mild measures and its history is full of combats and defeats. It was beaten in Coeur d'Alene in 1899; in Cripple Creek in 1903-1904; in Goldfield in 1907; and in the copper mines in Michigan in 1913-1914. All of these strikes were marked by violence, and in all of them men were killed; in most martial law was declared. Violence was avoided at the Homestake Mine, Lead, South Dakota, in 1909, by a lockout and subsequent employment of non-union labor.[32]

The stronghold of the Western Federation of Miners was in Butte, Montana. Internal discord and the entrance of the I. W. W. into the camp, in 1914, has destroyed the power of the Federation; for the present, at least, Butte is an open-shop camp.

The Industrial Workers of the World ("I. W. W.").

The I. W. W. is found wherever a strike is in progress and has been prominent in a number of mining strikes.[77, 78] Its aim is to destroy capitalism and the wage system. The movement is said to have started in France sixteen years ago. The first conference in the United States was in 1904; in 1908 a split took place between the believers in political action, who now have headquarters at Detroit, and the more radical members who reject political and advocate "direct action"; their home is in Chicago, Wm. D. Haywood, General Secretary-Treasurer; Jos. J. Ettor, Assistant Secretary and General Organizer. The Chicago organization reports 70,000 members: both the Detroit and the Chicago branches retain the name of Industrial Workers of the World. The preamble of the Chicago workers is: "The working class and the employing class have nothing in common. Between these two classes a struggle must go on until the workers of the world organize as a class, take possession of the earth and the machinery of production, and abolish the wage system.

"We find that the centering of the management of industries into fewer and fewer hands makes the trades unions unable to cope with the ever-growing power of the employing class. The trades unions foster a state of affairs which allows one set of workers to be pitted against another set of workers in the same industry thereby helping defeat one another in wage wars. Moreover, the trades unions aid the employing class to mislead the workers into the belief that the working class have interests in common with their employers. These conditions can be changed and the interest of the working class upheld only by an organization formed in such a way that all its members in any one industry, or in all industries, if necessary, cease work whenever a strike or lockout is on in any department thereof, thus making an injury to one an injury to all. Instead of the conservative motto: 'A fair day's wage

for a fair day's work', we must inscribe on our banner the revolutionary watchward, 'Abolition of the wage system.' "[5]

I have been unable to learn that either branch of the I. W. W. has any definite program for organizing industry after the destruction of the wage system.[79] The I. W. W. typifies the profound dissatisfaction that many feel with the organization of modern society: whether this movement will die out, as so many thousands of similar movements have done in the past, or will grow powerful enough to influence the future of the country, is a grave question.

As both the United Mine Workers of America and the Western Federation of Miners are members of the American Federation of Labor, it seems worth while to state that this body had a membership of 2,020,671 in 1914;[80] this is said to be 72 per cent of the trade unionists in the United States and in Canada; from this I estimate that the trade unionists in the United States are not more than 21 per cent of the total number of workmen engaged in mining, manufacturing and transportation, and not more than 7 per cent of all those engaged in gainful occupations.

The objects of the American Federation are the rendering of employment and subsistence less precarious by securing to workers an equitable share of the fruits of their labor.

STRIKES.

Early Mining Strikes.

Strikes are as natural to the mining industry as eruptions to a volcano, and living in a mining town is much like living on a volcano—one never knows when there is to be an explosion. A summary of strikes in all the industries of the United States for the period 1881-1905 showed that the strike-percentage of all the establishments in each industry varied from 9.72 in slaughtering and meat packing to 96.71 in coal and coke—ore mining showed 84.55 per cent.[59] The duration of the strikes varied from 4.6 days in agriculture to 83.2 days in ore mining—coal and coke 50.9 days.

The 16th annual report of the Commissioner of Labor contains a description of strikes in the United States prior to 1881.[29] The earliest mining strike mentioned was in 1848, in

the coal mines on the Monongahela River, Pennsylvania, where the price paid per bushel for digging coal was 2¾ cents and the miners struck against the proposed reduction to 1¾ cents. In 1859, complaints of inaccurate weighing and the demand for a weighing scale at the pit's mouth led to a strike in several Pennsylvanian counties; women took part and a number were arrested. To write the history of strikes in the United States would require volumes; I will give here merely a few details of those strikes that seem most instructive, and express the hope that some historian may take up this subject, which is certainly full of interest to the sociologist. In 1877 a three months' coal strike in Pennsylvania was closely connected with the most destructive strike yet known, wherein 1600 railway cars and 126 locomotives and many buildings were destroyed, the total loss being estimated at $5,000,000; many men were killed, among them several soldiers.

"On May 12, 1902, the miners in the anthracite region of Pennsylvania, members of the United Mine Workers of America, went on a strike to secure from the mine operators an advance in wages, a reduction in the hours of labor, and recognition of the union. This strike lasted five months, involved 147,000 workmen, practically closed the mines, and created a coal famine throughout the country".[60] It was settled by a commission appointed by President Roosevelt, which advanced wages and forbade discrimination between union and non-union workmen.

The Paint Creek Strike.

The Paint Creek strike in the Kanawha District, West Virginia, April 19, 1912 to July 29, 1913, cost $4,612,000 in loss of business, wages, and property and 13 men were killed.[61] This was one of the most bitterly fought strikes in the United States and was the subject of a Congressional investigation. Mine guards were obtained from the Baldwin-Felts Detective Agency, but were replaced by militia when martial law was declared on September 3, 1912. A potent agent for violence in this strike was "Mother Jones, the Miner's Angel", a woman whose "eighty years or more had not dimmed her eye, weakened the strength of her personality, or tempered the violence of her language"; she has been prominent in strikes for many

years and is said to be more influential for violence than any four other agitators in this country. Her last strike was in Colorado in 1914.

After martial law was declared, the 149 Baldwin-Felt Detective Agency mine guards were replaced by militia; the militia was recalled on October 14, and new guards, supposedly satisfactory to both mine operators and miners were appointed, but on November 15 martial law was again declared and again revoked December 12. On February 7, 1913, an armored train was fired on and replied with a machine gun, killing a miner and wounding a woman in a tent colony. Martial law was declared for the third time on February 10, and remained in force till June, when the strike was practically ended. Evictions by mine guards were a source of keen bitterness in this strike, and the action of the military commission, which had been appointed by the governor, in sentencing men to long periods of imprisonment without jury trial and without giving the prisoners any chance for defense, although the state courts were in session at the same time, was another source of bitterness, not removed by the decision of the state supreme court that such proceedings were legal.

''Practically all the strikers' demands were granted. Not only did they win a 12 per cent increase in pay, through a change from the long to the short ton, but they gained a nine-hour day, semi-monthly pay, the right to employ one of their own members as check-weighman, and the privilege of dealing where they pleased; they also secured the introduction of the check-off system, whereby union dues are deducted from the pay by the company and turned over to the union officials''.[62]

The Colorado Coal Strike of 1913-1914.

The most recent mining strike of any magnitude was in Southern Colorado and was caused by the United Mine Workers of America's attempt to unionize the coal mines.[33] According to the mine operators' statement, these miners are making the highest wages of any coal miners in the United States: the annual wages for all miners in the Victor American Fuel Co. for the year ending June 30, 1913, were $1,100.75; for the same period the miners of the Colorado Fuel and Iron Co. made $999.36; the average thus being more than twice that of the

anthracite miners of Pennsylvania. The chief complaint of the miners was that the companies controlled all the activities of the camps, commercial, political, and religious, and that they had no freedom except to work and keep their mouths shut; the mining laws of Colorado were said to be constantly violated and no redress was possible because the companies controlled the courts to such an extent that in some of the counties no suit had been decided against a company for many years.[64] These statements of the miners are confirmed by the report of the Congressional investigating committee from which I quote the following: "* * * * witnesses who testified as to the conditions existing in both Las Animas and Huerfano Counties. This testimony leaves little doubt as to the deplorable conditions existing there as to the denial of social and political justice. No thinking person can read the testimony taken by your committee and of other investigating commissions of the industrial disturbances in Southern Colorado without being convinced that fundamentally and underlying all these disturbances there must be some evil which right thinking and acting people would be able to correct".[64]

The operators' summary of the conditions attending the strike is as follows: "The present controversy is not a strike, for the reasons: First, the employes did not vote to call a strike; second, the majority of the miners did not walk out on the call, less than 25 per cent responding thereto.

"In addition to those who responded to the call, probably 10 per cent desiring to free themselves from the war threatened by the call of the strike, left the State. More than 60 per cent of the men remained at their posts of duty.

"Instead of a strike, this controversy is an armed insurrection against the sovereign authority of the State of Colorado, conceived, planned, financed, managed and directed by the officers and leaders of the United Mine Workers of America".[33]

Mr. Parker writes of this strike as follows: "The most serious difficulty of the year was in Colorado, where in an attempt to force recognition of the union upon the operators a strike was called to take effect on September 23, and from that date until the close of the year a state of affairs bordering on civil war existed. The fair name of the State was be-

smirched by acts of bloodshed, arson, and other excesses which the military arm of the State was unable to stop, and it was finally necessary to call in the aid of the United States troops to re-establish law and order. In the entire State of Colorado 7,324 men out of a total of 11,990 were idle for an average of 75 days, and the production of the year was reduced about 16 per cent''.[3]

The strike referred to in the foregoing remarks was effective September 23, 1913. On October 28, the State militia was ordered out and troops sent into the disturbed district; these were: infantry, 400; cavalry, 100; artillery, 56; medical corps, 24; signal corps, 30—in all, 610 men.[65]

In addition to the militia, the Baldwin-Felt Detective Agency furnished mine guards. In the artillery were at least 12 machine guns. At this time the strikers had from 1,500 to 2,000 armed men in the region and ten mine employes had been killed. A series of skirmishes were fought, culminating in the burning of the tent colony at Ludlow, on April 20, 1914, where 11 children and 2 women were suffocated. The loss of life in this strike is unknown; I have seen it estimated as high as 200; R. W. Austin, one of the members of the Congressional investigating committee, states: ''Loss of over 60 lives and property, business, and wages amounting to $18,000,000 * * * 80 per cent of the strike-breakers and 80 per cent of the strikers were foreigners''.[64]

The ''Ludlow massacre'',[63] as it is called, brought forth Federal troops: 1,500 cavalry arrived about May 1, and after their arrival peace prevailed. The strike was called off on midnight, December 9, 1914.[65]

Eugene S. Gaddis, a Methodist minister, formerly in charge of the Colorado Fuel & Iron Co.'s sociological department, testified that though the strike was technically lost, ''in reality it was one of the greatest labor victories ever achieved in the United States, because today the coal operators have their ear to the ground and will be very careful in the future''.[66]

During the progress of the negotiations, representatives of the operators refused to meet representatives of the miners, although they were in adjoining rooms.[67] It is the belief of

persons familiar with the situation that had this meeting taken place the strike could have been settled without recognition of the United Mine Workers.

This refusal of mine operators to meet representatives of the miners occurs in many mining strikes and is usually a precursor of serious trouble. It does seem that when there is a chance to settle a strike peaceably and avoid great loss of life mine operators ought not to stand on their dignity, but should meet the representatives of the miner—there is nothing so likely to lead to harmony as personal interviews.

This strike reflects credit on no one, and least of all on the State of Colorado. Some Coloradans were so indignant at Governor Ammons' confession of the inability of the State to maintain order—in his appeal to President Wilson for Federal troops—that "they suggested the State should surrender its sovereignty and revert to a territory".[68]

Such various statements are made with regard to this strike that it is difficult to say wherein the truth lies. The reader who is curious about the matter should look up the references that I have given; especially informing are the speeches in the Congressional Record.

Coeur d'Alene Strike.

The strikes mentioned above are enough to give some idea of what happens in the coal-fields, and I will now give a brief account of some of the more interesting strikes in the Western metal mines. Probably the most dramatic incident that ever took place in a strike in the United States was the capture of a train at Burke, Idaho, by the Coeur d'Alene miners on April 29, 1899: stopping the train at Gem they broke into a magazine, took out 3,000 pounds of dynamite, and continued on the train to Wardner; their number was increased by various strikers en route, until they were more than a thousand strong on their arrival at the concentrator of the Bunker Hill & Sullivan Co. Driving off the company's employes they blew the concentrator into kindling wood and retired in good order, after having killed two men and destroyed property worth $250,000.[69, 70]

Cripple Creek Strikes.

Among all the fierce strikes in the Western metal mines there is none to compare in physical, psychologic and political

interest with the strikes at Cripple Creek District, in 1894 and 1903-1904.[71] In addition to the usual elements of striking miners, mine owners, detectives, thugs, strike-breakers, are seen the influences of the national political parties and a State government first on the side of the strikers, then favoring the mine owners.

The first strike was in 1894 and was caused by the desire of the mine owners to establish a uniform ten-hour shift in the mines in which the workday varied from 8 to 10 hours. This attempt was resisted by the members of the Western Federation of Miners and a mimic war resulted, the miners establishing themselves on Bull Hill, whence they made a night attack on a large number of deputy sheriffs; in this attack five miners were captured and were formally exchanged a few days later for three prisoners taken from the Strong shaft by the miners. An interesting weapon, combining ancient and ultra-modern features, was a huge catapult that the miners mounted on Bull Hill and whose purpose was to throw beer bottles full of dynamite. Through the influence of the militia the attack of the deputies was stopped. The governor of Colorado interfered actively on the side of the strikers and the final result was a victory for the miners, who were granted an eight-hour day and recognition of the Western Federation of Miners, but non-union men were allowed to work in the mines. In view of the fact that this strike took place after a panic and when large numbers of miners were idle, the victory of the miners was certainly due to the active efforts of the State government. Out of some 300 men arrested, five were tried and given short sentences; the remainder were set free without trial.

Second Cripple Creek Strike.

From 1894 to 1903 Cripple Creek was fairly peaceful; during this period the Western Federation had grown much stronger and now controlled the county politically. Although union and non-union miners worked side by side in several mines, strong efforts were made to convert the non-unionists, and many of them were forced to leave the district.

"A statement of the conditions (leading to this strike) cannot be complete without a word upon the status of eight-hour day legislation in Colorado at just this time (July, 1903).

The State legislature in 1899 had passed an act limiting the labor day in mines, smelters and reduction plants to eight hours. * * * In 1902 a constitutional amendment was passed by popular vote commanding the legislature to pass an eight-hour act. But when the legislature convened in 1903 a powerful lobby appeared upon the scene. Conflicting bills were introduced, and loaded with a confusion of dispute-provoking amendments. The two houses could not agree upon a measure, and adjourned in April, having accomplished nothing.

"Upon the failure of the eight-hour legislation the Western Federation inaugurated a vigorous campaign of organization and strikes".[71] There were several small strikes in Colorado City, where the ores of the Cripple Creek mines were milled, and on July 3, 1903, a strike was called and only nine men came out. At this time there was no trouble in the Cripple Creek mines, but in order to stop the mines sending ore to the mills a strike was ordered for August 8. This strike was ordered by the small governing body of the Western Federation, and it is certain that the great majority of the miners were opposed to it.

The mine owners decided to fight the Federation and started up the El Paso Mine on August 13; beating of men and other violence resulting, the militia were ordered into the district; they arrived September 4; many arrests of union men immediately followed, but the force working increased; by October 10, 2,900 men were employed, 1,200 of these in the Portland and other "fair" companies. On November 14 an attempt was made to wreck a train; no one has been punished for this crime, but much evidence was brought out in the court examination to show that it was a plot of detectives to inflame the citizens against the Western Federation. On November 21 an explosion in the Vindicator shaft killed the superintendent and shift boss, but no criminals were arrested. Many union men were arrested and driven out of the district about this time.

On June 6, 1904, at 2:15 a. m., the platform of the Independence station was blown up and 13 out of 27 non-union miners belonging to the night shift of the Findlay Mine were killed; for this crime, too, no one has been punished legally. It was, however, the signal for a violent outburst against the

Western Federation; riots took place in several towns of the district and the miners' union halls were wrecked and men were killed. The Citizens' Alliance and the mine owners decided that the members of the Western Federation must leave the district; seventy-two men were deported on June 10, and in all 225 men were driven from the State and many more left voluntarily; the militia aided this movement in every way possible.

The Portland Mine, which had been running as a "fair" mine during the strike, was compelled to shut down by order of the militia on June 9. By July 26 the strike was over and the militia was withdrawn.[71]

The Cripple Creek strike sowed the seeds of resentment that have borne a plentiful crop of hate and dissension, and its effects will be felt for a long time to come. Many of the men concerned in this strike were in Goldfield, Nevada, in 1905-1908, and in their turn ran their enemies out of town. A demand for the recognition of the Western Federation led to the calling of Federal troops, who kept peace in a dangerously turbulent district and enabled the mine owners to employ non-union labor.

Remedies for Strikes.

Our American method of deciding labor disputes with high-power rifles and machine-guns, though fashionable at present, does not indicate a high state of civilization. Some better method must be found. The Australian[81] and New Zealand[82] legislation has been effective in lessening strikes, but it has not entirely done away with them. H. Weinstock, special labor commissioner for California, visited Europe and Australia during 1908 and 1909 for the express purpose of studying remedies for strikes and lockouts; he recommends legislation that will require the submission of all labor disputes to a State Labor Commissioner; if the latter is unable to bring about an agreement between the parties to the dispute, a commission of three members is to be appointed to establish a fair and equitable basis of settlement; if this settlement is not accepted it is to be published in the press; only after such publication may a strike be legally declared. Strikes and lockouts taking place

before the above inquiry and findings are completed are to be punished by a fine.[83] The Canadian Industrial Disputes Investigation Act[72] is very similar to that proposed by Weinstock; during the five years that it has been in operation it has settled 118 out of 124 trade disputes and "in four of the remaining cases settlement was brought about through negotiation and intervention of a citizens' committee and government agents. Two cases remained unsettled at the time of the last report". That is: 98.4 per cent of the disputes were settled without a strike, whereas under voluntary arbitration there have been strikes and lockouts in about 97 per cent of the cases and peaceful settlement in 3 per cent. An act very closely resembling the Canadian, and entitled the Labor Disputes Investigation Act, was passed in New Zealand in April, 1914; this provides for a conference of the parties with a view to securing amicable settlements—up to November, 1914, no disputes had arisen under this act.[84]

As far as I can learn, many unions in this country do not look favorably on governmental interference in labor disputes, but prefer strikes. It should, however, be remembered that there are three parties to every strike—the workmen, the operators, and the public. And, certainly, the interests of the public will be much better served by a peaceful settlement. In particular, the public is entitled to a fuller knowledge of the matters in dispute than the oft-repeated dictum of the operators, "there is nothing to arbitrate".

But if strikes and lockouts cannot be avoided, we ought, at the very least, to do away with the employment of armed mine guards, furnished by detective agencies. The use of these mercenaries shows that in this regard the United States is no farther advanced than was Europe in the fourteenth century, when wars were waged by the aid of the condottieri.[85]

The committee on Federal Industrial Relations is to conclude its examination into the methods of avoiding and adjusting labor disputes in August, 1915; it is remotely possible that remedial legislation may result from its investigations. Let us hope that such may be the case and that the detective-agency thug, the high-power rifle, and the machine gun may no longer be used as a means of deciding industrial disputes.

FUTURE PRODUCTION OF MINERALS; WASTE; CONSERVATION.

As the years roll on we use more and more minerals; the questions naturally arise: How long will our supplies last; is there any danger of our mines giving out? These questions have been studied by our scientists, and I will give a brief summary of their conclusions; the best resumé is by Van Hise.[42, 86]

The Mineral Fuels.

Coal.—When the United States was first settled, fuel was provided by the dense forests, but by 1830 there was a production of 320,072 tons of coal for a population of 12,866,020, or approximately 50 pounds per person; in 1909 the 91,972,266 population produced 460,814,616 tons, or, roughly, 10,000 pounds per capita: thus the per capita consumption had increased 200 times and the total production about 1,440 times.[3] Evidently production cannot long continue to increase at this rate, for it would require a sphere of coal the size of the earth to satisfy the demands of a few hundred years.

"Campbell and Parker estimate the aggregate coal area of the United States to be approximately 500,000 square miles, or about 13 per cent of the area of the country. They estimate at the end of 1907 that in this region there were available 3,076,204,000,000 tons of coal, of which one-third will be accessible only with difficulty. They estimate under present conditions the available and accessible coal at 1,922,979,000,000 tons * * *".[42]

If past history be a criterion, the waste in mining this coal will be prodigious. Van Hise estimates that for a production of 7,240,000,000 tons, up to the end of 1908, at least 3,695,000,000 tons more have been wasted. Parsons estimates a total waste of 2,000,000,000 tons of anthracite and 3,000,000,000 of bituminous coal. Holmes states that in mining we waste about half as much coal as we produce—this would be about 285,000,000 tons for our production of 1913.[87]

This waste was caused by leaving pillars of coal in the mine to support the workings, by working one only of several seams of coal, by producing fine coal and dust that was unsalable. Dr. R. W. Raymond suggests that the best remedy for these wastes is not legislation, but allowing the coal mines to

pass into the hands of corporations financially powerful enough to adopt the most scientific methods of mining and able to use costly machinery and to do preliminary deadwork that is not possible for small capitalists.[88] This passing of coal fields into strong hands is very marked in the anthracite fields of Pennsylvania, where 96.29 per cent is now in the control of a few companies.[72]

Recently great improvements have been made in coal mining; an extraction of 97 per cent of all the coal is predicted in some of the West Virginia mines where an actual extraction of 94 per cent has been reached in the mining of 300 acres.[89]

Mr. Gannett has calculated that our total coal supply, provided that the present rate of increased consumption continued, would last until about 2,050.[42] His calculations were made some years ago and I have made a rough estimate based on the rate of increase in the production of coal from 1903 to 1913 and find that it would take until about 2,085 to exhaust the total amount of Campbell and Parker's estimate, allowing nothing for loss. These calculations show that it is impossible for the production of coal to increase at the present rate for any great length of time.

As a matter of interest, I mention that the coal reserves of the entire world are estimated at 7,397,553,000,000 tons; as the annual production for recent years was 1,443,393,000 tons, these reserves show a world supply of 5,125 years; on the same basis, that is, allowing nothing for increased consumption, the 3,076,204,000 tons in the United States is enough for 5,395 years; hence, as the rate on consumption is increasing all over the world, it appears that the coal supply will be exhausted within a few centuries, unless the present rate of increase ceases.[90]

Petroleum.—The quantity of petroleum produced in the United States, in 1913, was 248,446,230 barrels of 42 gallons each, worth $237,121,388, or about 95 cents a barrel; the oil-fields of the United States are supposed to cover an area of 8,500 square miles, with a reserve of from 10,000,000,000 to 25,000,000,000 barrels; taking the larger estimate it is seen that the reserve is about enough for 100 years at the rate of production for 1913.[42] The experts of the United States Geological

Survey state that within a very few years a marked decline in production will be noted, and that after ten years there will be an insufficient supply for legitimate demands, unless the present supply is supplemented from new fields.[92]

In the extraction of petroleum the greatest waste is caused by the infiltration of water which replaces the oil and may ruin a promising district; burning wells, too, cause a large loss of oil, and much loss is incurred in storage and in transportation; the total annual loss from these causes, most of which are preventable, is estimated by the Bureau of Mines at not less than $50,000,000 annually.[6]

In order to conserve its petroleum, the United States has withdrawn large areas of oil lands; this is probably a wise move, but whether those persons who attempted to develop those areas previous to withdrawal have been fairly treated is a moot question. Much can be done to save petroleum by the curtailing of its use as a source of power, by substituting fuel or water-power, and by the prohibition of exportation.

In view of the unique nature of petroleum, the apparent impossibility of replacing it as a lubricant, and its limited supply it is a question if it would not be wise for the government to establish a minimum price for its sale and to forbid its use for generating power, for which purpose coal and hydraulic energy can be employed.

A curious feature of the petroleum industry in California is that the producers are not getting a fair return on their capital, for the simple reason that the price of oil is too low. "Only in exceptional cases is oil production profitable when less than 40 cents per barrel is received".[93] At present, June, 1915, the price is just about 40 cents.

The world's production of petroleum for 1913 was 381,508,916 barrels, the production of the United States, 248,446,230 barrels, being 65 per cent of the world's production.[3] Oil fields are being studied in the Argentine, Egypt, and in the Province of Shensi, in China, and in other portions of the world and some of these new fields will undoubtedly bring out a large production; but, on the whole, there is every reason to think that the present wasteful use of petroleum must be greatly diminished in the near future.

Natural Gas.—"Natural gas occurs in commercial quantities in 23 States of the United States, and the production in the calendar year 1911 was 508,353,241,000 cubic feet, having a total value of $74,127,534. The estimated total area of the gas fields in the country is given as 9,365 square miles".[94]

This ideal fuel first came into extensive use in the 80's; the production for 1882 was valued at $215,000 (the average value for 1911, as given above, was 14.58 cents per 1,000 cubic feet). For 1888 the product was valued at $22,629,875, then there was a drop to $13,002,512 in 1896, from which time the production has increased until it amounted to $87,846,677 in 1913. Whole districts have used up their supply of natural gas and have had to go back to coal. The reserves of gas are unknown, but Day does not think that they will much exceed 25 years at the present rate of consumption.[3, 42]

"There is no natural resource which has been so carelessly used and recklessly wasted by the American people".[42] "The history of the natural-gas industry of the United States is an appalling record of incredible waste".[94] The above statements are substantially repeated by all students of the history of natural gas. The waste has been partly due to its use under boilers to make steam, instead of employing it in gas engines, but its chief waste has been in allowing its free escape into the air. I have not been able to find any estimate giving the annual loss, but Arnold and Clapp state: "the value of the gas wasted by permitting 'wild' wells to flow into the air is hundreds of thousands of dollars per day. This is an absolute waste * *".[94] Others estimate the loss at more than 50 per cent of the production.[95] Some wells have been burning for 20 years; at one time in the Caddo field in Louisiana the loss was 70,000,000 cubic feet daily or a value of about $10,000. The greatest waste, perhaps, took place in West Virginia and was vigorously combatted by the State Geologist, I. C. White, who estimated it at 250,000,000 cubic feet daily, or say, $13,000,000 annually. White tried in vain for years to have regulatory legislation passed, but unsuccessfully. It is stated, however, that the operators themselves have greatly diminished the waste.[42] Now (1912) the greatest waste is taking place in California, Louisiana, and Oklahoma.[94] In thus "wasting our

resources, we have been guilty of more stupendous folly than any other people in the civilized world'', so says Van Hise; but why limit his rebuke to the civilized world? In all probability no non-civilized men ever had the opportunity to waste so much valuable material. Moreover, history teaches us that non-civilized man was a better conservationist than we have been: witness the buffalo of this country and the guano deposits off the west coast of South America—not to give further details.[42]

The Bureau of Mines is working on this problem of stopping the waste of natural gas and has issued several papers on the subject.[6] In addition to publishing and investigating, the Bureau has done practical work in the field and has saved some $15,000,000 worth of natural gas by the expenditure of less than $15,000. I have not seen any details of this work, but I believe that it was by the use of mud-laden water in the wells of Oklahoma, during 1913-1914.[96]

The Metallic Resources.

Iron.—Dr Hayes, chief geologist of the United States Geological Survey, estimates the available iron ores of this country at 4,788,150,000 long tons; low grade ores, not now available, but which may become available in the future, 75,116,070,000 long tons; the bulk of these ores are in the Lake Superior region. In addition to these ores there are very large deposits in Canada, Cuba, and Brazil that are in part controlled by American capitalists and which are now being used, or will be used in future in our furnaces.[42]

The production of iron ore has increased prodigiously; I quote this table from Van Hise:

Production of Iron Ore in the United States, Estimated from Pig Iron Production.

	Long tons	Percentage of increase
1810-1869	49,656,000	....
1870-1879	43,770,527	....
1880-1889	91,043,854	108.0
1890-1899	163,989,193	80.1
1900-1909	386,857,102	135.2
Total	735,316,676	

The production of iron per capita has also greatly increased —180 pounds in 1870, 1344 in 1907 and about 1400 in 1913.

In 1913 the production of iron ore in the United States was 61,980,437 long tons; if the present rate of increase in the production of iron ores is continued it is estimated that by 1950 the high grade ores will be exhausted. The following causes, however, will undoubtedly prolong the life of these ores: more careful mining; discovery of new deposits; substitution of stone and cement in building; increase in price of iron; use of lower grade ores; importation of foreign ores; re-use of present stock of iron; less demand for iron owing to lessened railroad-building and less city-building. But allowing for all these causes, the exhaustion of the world's iron ores seems to be but a few centuries away at most.

Copper.—The following table gives the production of copper for a few selected years:

Metallic Copper Produced in Selected Years—Gross Tons.

1845	100 [42]
1852	1,100 [42]
1867	10,000 [42]
1883	51,574 [42]
1888	101,054 [42]
1896	205,384 [42]
1905	402,637 [42]
1912 (short tons)	621,634 [3]
1913 (short tons)	612,242 [3]

It will be noted that the production for 1913 is slightly less than for 1912; and while the maximum production for the United States may not yet have been reached, it seems likely that it will be reached within a very few years. The reserves of copper ore are large, especially in the porphyry mines that have lately been so successfully developed; these mines show hundreds of millions of tons of ore running up to 3 percent copper. The life of the great Calumet and Hecla mine in Michigan, has been given as about 30 years. In absence of fuller information all that can be safely said is that while there are very large known reserves of copper ore, there is no great probability of their lasting more than a century or two longer at the present rate of production.

There may be an increase in the world's production for some time to come from the remarkably rich mines in the Katanga region of Africa; and South America and Siberia are also likely to develop large production, as well as Western China. At present the United States produces about 55 percent of the world's product.

Waste in copper is principally in the concentration, where the losses run 30 percent or more. The flotation process will be of great benefit to this industry.

Gold.—There are no trustworthy estimates as to the world's production of gold until recent years. Tables of the production usually start with the year of the discovery of America, but the figures given are probably little better than mere guesses. Soetbeer estimates the gold produced prior to 1600 as 750 tons. In view of the fact that great treasures of gold are reported by the ancients and that gold mining had made progress in widely separated parts of the world—for example, India, Central Asia, Russia, South Africa, China, Hungary, Spain, Great Britain, Egypt, Mexico, Peru, Central America—it seems as if Soetbeer's estimate is much too small. I give below a table showing the world's production for a few selected years.

World's Production of Gold.

	Total	Annual Production
1493-1520	$107,836,848	$ 3,851,316
1701-1720	167,875,680	8,393,784
1741-1760	326,831,120	16,341,556
1811-1820	75,998,160	7,599,816
1831-1840	135,722,280	13,572,228
1841-1850	363,609,260	36,360,926
1851		67,600,000
1852		132,800,000
1874		90,800,000
1895		201,292,265
1911		459,377,300
1912		474,333,268
1913		463,312,673
1914		455,305,385

The figures from 1493 to 1895 are from Crane;[2] those for 1911 to 1914 are from the Engineering & Mining Journal.

The production of the United States for selected years has been:

Production of Gold in United States.

1847	$ 889,000
1848	10,000,000
1849	40,000,000
1853	65,000,000
1862	39,200,000
1866	53,500,000
1883	30,000,000
1909	99,673,400
1911	96,890,000
1912	93,451,500
1913	88,884,400
1914	92,823,500

The figures to 1909 are from Crane; those for 1911 to 1914 from the Engineering & Mining Journal.

A slight study of the above figures seems to show conclusively that gold is absolutely unfit for a standard of value, because of the wide variations in the amount produced annually. Just what influence this variation has on prices has not been authoritatively decided; one set of economists asserts that the great increase in gold production has raised prices while another group contends that the variation in prices bears no relation to the amount of gold produced.

Thus far the discussion has been as to whether the increased production of gold has raised prices. Many able engineers think that gold production has reached a maximum and if production decreases materially within the next few years there will be a better opportunity of deciding as to its influence on prices.

Silver.—The past production of silver is given for selected years in the following table:

Annual Production of Silver in Kilogrammes.

	Kilos.
1493-1520	47,000 [2]
1601-1620	422,000 [2]
1801-1810	894,150 [2]
1821-1830	460,560 [2]
1861	1,013,617 [2]
1872	2,034,852 [2]
1890	4,180,532 [2]

1893	5,339,746 [2]
1908	6,612,304 [98]
1909	7,069,656 [98]
1911	7,906,446 [98]
1912	7,806,516 [98]

The production of silver in the United States for selected years was:

Production of Silver in the United States.

	Fine ounces	Commercial Value
Total production from 1792 to 1844	193,400	$ 253,400
From 1845 to 1858, annual production about	38,700	52,000 [2]
1859	77,300	105,100 [2]
1861	1,546,900	2,062,000 [2]
1863	6,574,200	8,842,300 [2]
1870	12,375,000	16,434,000 [2]
1874	28,868,200	36,917,500 [2]
1891	58,330,000	57,630,000 [2]
1911	60,399,400	32,615,700 [3]
1912	63,766,800	39,197,500 [3]
1913	66,801,500	40,348,100 [3]

These figures indicate a gradual growth in the production of silver that has not been checked by the sharp fall in price, which during the last fifty years has fallen from a maximum of about $1.34 per troy ounce to less than half that price—New York prices from 1904 to 1913 varied from 52 to 68 cents: the average of 1913 was 60.4 cents.[3]

Not enough evidence is available to predict the production of silver in the future, but it seems probable that for a few years to come the variation from the present production will not be great.

Lead.

Production of Lead in the United States, in Short Tons, from Domestic Ores.[3] [42]

1825	1,500
1832	10,000
1874	52,080
1881	117,085
1897	207,365
1907	337,340
1912	392,517
1913	411,478

Lead was one of the earliest metals mined in the United States. As is noted above, its production is increasing. I have no statistics that throw any light on its future. Losses in lead mining, especially in Missouri, are said to be high—an estimate is that not less than 15 percent of the ore is left in the ground and the losses in smelting and concentration average 50 percent. Our production is about 31 percent of the world's product.

Zinc.—Zinc mining is comparatively new and statistics are only available since 1873.

Metallic Zinc Produced in Selected Years in the United States. Short Tons.[3 42]

1873	7,343
1887	50,340
1897	99,980
1905	203,849
1912	338,806
1913	346,676

The losses in mining and smelting zinc are very great; Van Hise is informed that in some Missouri mines not over 30 to 35 percent of the amount in the ore deposit is recovered in the form of metallic zinc. The great losses are in part due to the system of leasing mines; the excessive royalties of from 20 to 35 percent demanded lead the lessees to work only the high-grade ores.

Phosphates.

Phosphorus.—I quote from Van Hise:

"Even at best it is difficult to see how agriculture can be carried on without loss of phosphorus. * * * it is the crucial element in soil fertility. If we retain the phosphorus of the soil, it can be used again and again through an indefinite future, like a circulating medium. An ounce of gold made into a coin may be used a thousand times, or may be kept in a vault and used as a basis of a gold certificate through thousands of years. Similarly this element phosphorus, incomparably of greater importance to us than all our gold and silver and copper and lead and zinc, must be retained as a resource of this nation. We could far more wisely export our output of the precious metals

with the certainty that it would not be returned to us than we can our phosphate rock. We could, if we must, get along without gold, or silver, or lead, or copper, or zinc. We cannot get along without food. The problem of the conservation of our phosphates therefore is the most crucial, the most important, the most far-reaching with reference to the future of this nation, of any of the problems of conservation''.[42]

Total Value of Minerals Wasted Annually in the United States.

The foregoing statements show that the total value of the minerals wasted in the United States annually is enormous. I have not seen any detailed estimate of this waste, but the Bureau of Mines, which is investigating the subject, states:

''The need of such investigations should be obvious to anyone who remembers that the Nation has but one supply, and that unreplaceable, of these resources, and that the total wastes or losses in mining and utilizing our mineral resources now amount to more than $1,000,000 a day''.[6]

In view of the data given in this article this estimate seems very moderate.

CONCLUSION.

In 1610, Sir George Selby told Parliament that the coalfields of Newcastle would be exhausted within 21 years, and in the past many other unfulfilled prophecies have been made.[91] Hence, some may doubt the justness of those prophecies that have lately been made as to the exhaustion of our chief minerals—especially coal and iron ores—within the next two or three hundred years. But the doubter should reflect that science, and especially mining geology, which has developed extraordinarily within the last thirty years, has given the modern prophet much more data on which to base his prophecies. And there is now a vast amount of evidence to show the likelihood of our being very near an era when the constantly increasing output from our mines must give place to decreased production; with such decrease the extraordinary industrial growth that we have enjoyed for so many years must stop and a decline set in. This change, from growth to stagnation and decline, will give rise to many problems for future generations to solve. It is evident that at no very distant date future

inventors must devise some means of replacing coal and iron ores—those mineral bases on which our social fabric rests. Possibly the inexhaustible stores of aluminum may replace the iron, and the energy of coal may be supplemented, or replaced, by that of the wind, flowing water, the tide and the sun's rays.

The thought probably comes to all who consider this question that any efforts we may make to conserve our minerals will avail but little. For if the scientists are right our coal and iron (for example) will be exhausted within two or three hundred years and the best we can do will be to extend their life for a few decades or, allowing for great errors in our present estimates, for a few centuries. This period is insignificant compared with the probable life of man, say a million years before he dies out as has the trilobite, the ichthyosaurus, and the mammoth.

Nevertheless, while our first duty is towards ourselves, and while there is no reason to stint ourselves for the problematic advantage of posterity, we certainly ought to do all we can to avoid waste while utilizing our mineral resources.

BIBLIOGRAPHY.

The Library of Congress publishes among others, the following list of references: Arbitration, Boycotts, Conservation, Eight-hour Day, Immigration, Labor. These are pamphlets costing 10 cents each and are to be had from the Superintendent of Documents, Washington. For full list see Library of Congress Publications. January, 1915.

Publications of the United States Geological Survey on metals and non-metals except fuels. List compiled by Isabel P. Evans, Bulletin 580-P, Washington, 1914.

The Engineering Annual Index, The Engineering Magazine Co., New York.

The Mining World Index of Current Literature, Mining World Co., Chicago.

Index of Mining Engineering Literature, Walter R. Crane, John Wiley and Sons, New York.

Index and Transactions of American Institute of Mining Engineers.

Labor Bibliography, Bureau of Statistics, Commonwealth of Massachusetts, No. 100, June, 1914.

''A Handbook of Labor Literature,'' Helen Marot, T. S. Leach & Co., 1899, Philadelphia.

Selected articles on compulsory arbitration of industrial disputes,

L. T. Beman, H. W. Wilson Co., 1911, Minneapolis. Bibliography of 28 pages in this.

Workmen's Compensation. Report upon operation of State laws. Investigation by commission of The American Federation of Labor and The National Civic Federation. Senate Doc. No. 419, 63d Congress, 2d Session.

References.

1 Georgius Agricola de re metallica. Translated from the first Latin edition of 1556 with biographical introduction, annotations and appendices upon the development of mining methods, metallurgical processes, geology, mineralogy, and mining law from the earliest times to the 16th Century. By Herbert Clark Hoover and Lou Henry Hoover. Published for the translators by The Mining Magazine. London, 1912. The notes on the history of mining, mining law and metallurgy are most valuable.

2 "Gold and Silver", Walter R. Crane, John Wiley & Sons, 1908, New York.

3 Mineral Resources of the United States, Calendar Year 1913, United States Geological Survey, Washington, 1914.

4 Thirteenth Census of the United States: 1910. Bulletin, Mining. Abstract-Statistics of mining for industries and States.

5 The World Almanac and Encyclopedia for 1915. Press Publishing Co., New York.

6 Fourth Annual Report of the Director of the Bureau of Mines. For the fiscal year ending June 30, 1914. Washington, 1914.

7 "Houses for Mining Towns", J. H. White, Bulletin 87, Bureau of Mines, Washington, 1914.

8 "The Panama Canal", G. W. Goethals, Scribner's Magazine, April, 1915.

9 Mining & Scientific Press, January 13, 1906.

10 Many articles on the subject of "salting" will be found in the mining journals; one of the latest is: "Placer Salting in Santo Domingo", J. R. Ledoux, Engineering & Mining Journal, February 14, 1914.

11 "Comstock Mining and Miners", Eliot Lord, U. S. Geological Survey, Washington, 1883.

12 "The Law of the Apex", R. W. Raymond, Trans. American Institute of Mining Engineers, Vol. XII, 1883-1884.

13 "Coal-mine Accidents in the United States and Foreign Countries", Compiled by F. W. Horton, Bureau of Mines, Bulletin 69, Washington, 1913.

14 Report of the Department of Mines, Pennsylvania, 1913.

15 "The Anthracite Coal Industry", Peter Roberts, Macmillan, 1901, New York.

16 Prehistoric Times, Avebury, Henry Holt, 1913, New York.

17 Letter from Sidney F. Mayers, formerly secretary to the British Legation, Peking, China.
18 Brockhaus konversations-lexicon, article ''Bergbau''.
19 ''Peru,'' E. Vivian, Appleton & Co., 1914, New York.
20 ''Mexican Archaeology'', T. A. Joyce, London, P. A. Warne, 1914.
21 Books on California pioneer days are countless; for a vivid description by a prominent actor in the demoralized society of pioneer days, see ''Reminiscences of Senator William M. Stewart of Nevada'', edited by George Rothwell Brown, New York, The Neal Publishing Co., 1908.
22 Weight 183 pounds, value about $40,000. Nelson's Encyclopaedia, Article ''Gold''.
23 Immigration Commission's Reports, Vol. 16, part 17, Copper mining and smelting; part 18, iron-ore mining; part 19, anthracite-coal mining; part 20, oil refining. 1910. 929 pages, illus. maps. (61st Congress, 2d sess. Sen. Doc. 633). Serial number 5677.
24 Immigration Commission's Reports, Vols. 6 and 7, Bituminous coal mining.
25 Immigration Commission's Reports, Vol. 5, Dictionary of races or peoples, paper 20 cents.
26 A useful little pamphlet that will keep the mine manager from classifying an employe as of ''Austrian'' race is ''Specimen verses of the principal languages and dialects into which the Holy Scriptures have been translated.'' American Bible Society. New York. 1914. Gratis. The British Bible Society issues a similar booklet.
27 ''The Immigration Problem'', J. W. Jenks and W. J. Lauck, New York, Funk and Wagnalls, 1913.
28 ''The Immigrant Invasion'', F. J. Warne, New York, Dodd, Mead & Co., 1913.
29 Sixteenth Annual Report of the United States Commissioner of Labor, 1901.
30 Letter from A. D. Foote, Manager North Star Mines, Grass Valley, California.
31 Letter from A. J. Stinson, Inspector of Mines, State of Nevada.
32 Testimony of T. J. Grier, Manager Homestake Mining Company, Proceedings United States Commission on Industrial Relations, Lead, South Dakota, August, 1914.
33 ''Facts Concerning the Struggle in Colorado for Industrial Freedom'', Series I, issued by the coal mine managers, 1914.
34 Second Annual Report of the State Bureau of Inspection, State of Indiana, Indianapolis, 1914.
35 Strike investigation of the Copper Country Commercial Club of Michigan, 1913.
36 ''The Immigrant, an Asset and a Liability'', F. J. Haskin, 1913.
37 ''The Standard of Living Among Workingmen's Families in New York City'', Robert Coit Chapin, Russell Sage Foundation, New York, 1909.

38 ''Infant Mortality'', Emma Duke, U. S. Department Labor, Children's Bureau, Washington, 1915.

39 ''The Record of a City, a Social Survey of Lowell, Mass.'', G. F. Kenngott, New York, Macmillan, 1912.

40 ''Expansion of Races'', C. E. Woodruff, New York, Rebman & Co.

41 Letter from F. Clowes, Secretary to the First Deputy Commissioner, Department Public Charities, New York, May 3, 1915.

42 ''The Conservation of Natural Resources in the United States'', C. R. Van Hise, New York, Macmillan, 1910.

43 Verbal information from officials of the Industrial Accident Board of California.

44 ''The Elements of Mining and Quarrying'', C. Le Neve Foster.

45 ''Coal-mining Fatalities in the United States'', compiled by Albert H. Fay, Technical paper 94, Bureau of Mines, Washington, 1914.

46 ''Metal-mine Accidents in the United States'', compiled by Albert H. Fay, Technical paper 94, Bureau of Mines, Washington, 1914.

47 ''Accident Death-rates. Witwatersrand Gold Mines'', from F. L. Hoffman, statistician of the Prudential Insurance Company.

48 Bulletin of the American Institute of Mining Engineers for May, 1915. Remarks by C. W. Goodale, page 1081.

49 First Biennial Report. Department of Labor and Industry, State of Montana, 1914.

50 ''Metal-mine Accidents in the United States During the Calendar Year 1912'', compiled by Albert H. Fay, Technical Paper 61, Bureau of Mines, Washington, 1913.

51 ''Safety Methods and Organization of the United States Coal and Coke Company'', Howard N. Eavenson, Bulletin of the American Institute of Mining Engineers, February, 1915, and discussion in Bulletin for May, 1915.

52 ''Enlarging the Worth of the Worker and the Perspective of the Employer'', J. Parke Channing, Bulletin American Institute of Mining Engineers, March, 1915; discussion in May Bulletin.

53 Proceedings of the 24th Convention of the United Mine Workers of America, Indianapolis, January 20 to February 3, 1914.

54 Bulletins and reports of the Industrial Accident Board of Ohio.

55 Report of the Nevada Industrial Commission for 1913-1914.

56 First Report of the Industrial Accident Board of California.

57 Workmen's Compensation Law, State of Montana, in effect July, 1915.

58 Addresses of C. F. Kelley and of Wm. B. Rodgers before Committees of Labor, Helena, Montana, 1913.

59 World Almanac for 1909.

60 World Almanac, 1903-1904.

61 ''The West Virginia Coal Strike'', Lawrence R. Lynch, Political Science Quarterly, December, 1914.

62 The New International Year Book, 1913.

63 ''The Ludlow Massacre'', pamphlet, Walter H. Fink.

64 Report on the Colorado strike investigation, House Document 1630, 63d Congress, 2d Session.

65 Letter from Colorado Fuel and Iron Company.

66 San Francisco Chronicle, May 20, 1915. Report of testimony before United States Commission on Industrial Relations.

67 Congressional Record, June 12, 1914, page 10345. Statement of ex-Senator Patterson.

68 ''The Colorado Mine Trouble'', Victor C. Alderson, formerly president of the Colorado School of Mines and Chairman of the State Investigation Committee, San Francisco Chronicle, April 12, 1915.

69 Report of Brig. Gen. H. C. Merriam, 56th Cong., 1st Sess., Sen. Doc. 142., Serial number 3851.

70 Report of the Industrial Commission on the relations of capital and labor, 57th Cong., 1st Sess., House Doc. 181, Serial number 4342.

71 ''The Labor History of the Cripple Creek District'', Benjamin McKee Rastall, Bulletin of the University of Wisconsin, Vol. III, 1908.

72 ''Conciliation and Arbitration in the Coal Industry of America'', Arthur E. Suffern, Boston, Houghton Mifflin Co., 1915.

73 Twenty-second Annual Report of the Colorado Fuel and Iron Co., for the year ending June 30, 1914.

74 ''Labor and Administration'', John R. Commons, New York, Macmillan, 1913.

75 Reprint from Bibliotheca Sacra., October, 1913.

76 Proceedings of the Western Federation of Miners, 18th Convention, July 18 to August 2, 1910.

77 ''American Syndicalism'', I. W. W., J. G. Brooks, New York, Macmillan, 1913.

78 Many five-cent booklets of the I. W. W.

79 Letter from Wm. D. Haywood, General Secretary-Treasurer, Industrial Workers of the World, Chicago, May 28, 1915.
Letter from H. Richter, General Secretary-Treasurer, The Industrial Workers of the World, Detroit, May 30, 1915.

80 American Year Book for 1914, New York, Appleton & Co.

81 Official Year Book of the Commonwealth of Australia, 1901-1913.

82 The New Zealand Official Year Book, 1914.

83 Special labor report on remedies for strikes and lockouts, Harris Weinstock, Special Labor Commissioner for California, Sacramento, 1910.

84 New Zealand Government, Department of Labor, Panama-Pacific International Exposition, 1915.

85 Violence and the Labor Movement, Robert Hunter, New York, Macmillan, 1914. Strongly partisan on the workmen's side, but should be studied; contains many references.

86 Report of the National Conservation Committee, 60th Cong., 2d Sess., Serial number 5399.

87 ''Notes on Mineral Wastes'', C. L. Parsons, Bulletin 47, Bureau of Mines, Washington, 1912.

88 ''Conservation of Natural Resources''. Meeting of engineers called jointly by the American Society of Civil Engineers, American Institute of Mining Engineers, etc. Published jointly by the Societies, New York, March 24, 1909.

89 ''Cost Factors in Coal Production'', W. H. Grady, Bulletin American Institute of Mining Engineers, May, 1915, page 1067.

90 ''The Coal Resources of the World'', Toronto, Morang & Co., 1913.

91 ''Dictionary of Political Economy'', Macmillan. Article ''Mines''.

92 ''Conservation of Mineral Resources'', Bulletin 394, United States Geological Survey, 1909.

93 ''Petroleum Industry of California'', R. P. McLaughlin, assisted by C. A. Waring, California State Mining Bureau, October, 1914.

94 ''Wastes in the Production and Utilization of Natural Gas and Means for Their Prevention'', Ralph Arnold and Frederick G. Clapp, Technical paper 38, Bureau of Mines, Washington, 1913.

95 ''Production and Waste of Mineral Resources'', J. A. Holmes, Annals American Academy, Vol. 33, 1909.

96 ''Mud-laden Fluid Applied to Well Drilling'', J. A. Pollard and A. G. Heggem, Technical Paper 66.

''The Prevention of Waste from Oil and Gas from Flowing Wells in California'', Ralph Arnold and V. R. Garfias, Technical Paper 42.

''Waste of Oil and Gas in the Mid-continent Field'', Raymond S. Blatchley, Technical Paper 45.

''Condensation of Gasoline from Natural Gas'', George A. Burrell and Frank M. Seibert, and G. G. Oberfell, Bulletin 88.

All the above (96) publications of the Bureau of Mines, Washington.

97 The foregoing statements on page 21 show that many of our workmen are underpaid; this is especially true of the ''new immigrant''. With this conclusion in view it seems strange to read that Austrian officials were greatly surprised when they saw returning emigrants, fleeing from the panic of 1907, decked out in fashionable garments, the women with tall ostrich plumes and the men, as a rule, wearing creased trousers and all of them wearing an astonishing air of prosperity. All had enough money to scorn the offer of a committee that expected to be obliged to care for famishing refugees and offered wages of 90 cents daily.[83]

98 ''The Mineral Industry for 1913'', McGraw-Hill Book Co., Inc., New York, 1914.

Paper No. 151

THE VALUATION OF METAL MINES.

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The present value of a mine is based on an estimate of future profits. The profits are expressed in terms of money. The value of money differs with time and place. While money is unlikely to differ in value notably in the same place during the relatively short life of a mine, it is likely to be affected by the condition of locality. Money is worth less at New York than at Tonopah, for example, the prevailing rate of interest in the one case being 4 or 5% and in the other from 8 to 12% per annum. This difference tends to facilitate the transfer of a mine from an owner in the desert to a capitalist in the city. The latter is content with a smaller return on his ''investment'', as he is apt to call it. The difference in the point of view tends to promote business.

In all business transactions the point of view is vital; hence the difference between the valuation of mines for purchase and the appraisal of them for taxation. Attempts have been made to put both kinds of estimation on the same basis. They have failed. The purchaser buys a mine to hold it and to exploit it until it is exhausted; when the purchase is completed, he cannot revise the transaction. If he buys with the idea of re-selling, he must do so on the supposition that the next buyer will act intelligently; that is, as a sensible man, the purchaser cannot assume an escape from a blunder by the interposition of somebody more foolish than himself. Such assumptions, it is true, are not uncommon, but they proceed on lines of reasoning outside the limits of an economic investigation. Therefore, I repeat, the purchaser whether an individual or a company, buys with a view to ex-

ploitation. The State, on the other hand, assesses the mining property annually, and is in a position to remedy any error in its estimate from year to year. The first appraisal is not irremediable; therefore it is not so momentous. Nevertheless the State authorities, recognizing the inherent difficulties of the problem and their incapacity to solve them, usually avoid them by simply taxing the output of the preceding year, that is, they prefer to deal with the statistics of actual production. They appear to recognize, or they may have merely surmised, that the antemortem diagnosis of a mine is necessarily aberrant. In truth, it is a tricky business. Having regard to the inherent difficulty of estimating future production, it is not surprising that the taxation of output has been adopted in most States as the most practicable method. It seems best for the purposes of annual taxation, even though it may fail to penalize those owners who choose to leave their properties idle in the hope of selling them at a higher price or of exploiting them when the market for their product is more favorable. This evasion can be checked, to some extent, by taxing the claim-area or acreage, whether productive or not, to such a degree as to render long idleness prohibitive.

The appraisal of mining properties for State taxation has had the good effect of drawing public attention to a subject heretofore deemed too recondite for general discussion. Mining engineers, among themselves and in the technical press, have touched upon the problems involved, but, on the whole, the solution of these problems has been deemed in the nature of a professional secret, to be left in the safekeeping of the individual. The active members of the profession, or practitioners, it may be inferred, consider it impolitic to publish the particular basis on which any one of them might see fit to value a mine for his client. If an engineer were to state beforehand that he could not report favorably unless certain fixed conditions were fulfilled, he might cause sundry vendors to object to having their property subjected to a test so exacting as to render business impracticable, with the further unpleasant consequence of placing a black mark against the name of the mine. Moreover, the criteria to be used in valuing different mines by the same engineer would vary in accordance with the character of the mining and of the client. In some

kinds of mining the uncertainties are vastly greater than in others; so also some clients are willing, and can afford, to take bigger risks than others. For reasons of this kind the scheme of valuation is rarely set down in black and white, not even for professional information, much less for public enlightenment.

Within recent years, however, the State of Michigan engaged a mining engineer of acknowledged repute, Mr. J. R. Finlay, to make an appraisal of its mining properties for purposes of taxation. Other State commissioners had tried to perform the same task under the guidance of politicians, labor-leaders, geologists, and various gentlemen distinguished by varying lack of fitness for the task. In this respect they were like the lay public, which is learning slowly and painfully that the only person likely to value a mine successfully is a mining engineer equipped with the requisite training and experience. It is fair to add, however, that the State of Wisconsin deputed the study of mine valuation and assessment in its zinc-producing territory to a member of its Geological Survey, namely, Mr. W. L. Uglow, whose report gives the impression that he also, although probably less versed in the management of mines, has envisaged the subject with convincing skill.

The official reports* issued as a sequel to the investigations made by Messrs. Finlay and Uglow furnish an excellent text for a general discussion of the subject. Mr. Finlay states that his appraisal is "a calculation of the value of mines to the permanent owner for the production of minerals". The value of a mine for share-market purposes is ignored; so is its value for the purpose of re-sale. Neither aspect of the problem came within his province. The calculation is based on three factors:

1. The average cost of production.
2. The average price obtained for the product.
3. The future life of the mine.

The first two are determined "by experience", that is, they can be ascertained by investigating the records of the mine and

* "Appraisal of Mining Properties of Michigan", by the State Board of Tax Commissioners. 1911.

"A Study of Methods of Mine Valuation and Assessment". Wisconsin Geological and Natural History Survey. 1914.

of the industry, with sagacious inferences therefrom. The third factor is "based partly on developed ore and partly upon an assumption of continuance of known orebodies beyond the present bottom levels of the mines".

From these three factors the future net profits, or dividends, are calculated. The present value of such dividends is then reduced by the annuity method to a sum upon which they will pay a given interest and at the same time provide an annual contribution into a sinking fund, which, re-invested, and added to prior installments similarly invested and re-invested, will redeem that sum within the period covered by the life of the mine. Mr. Finlay took 5% as the dividend interest and 4% as the rate of amortization. This may be accepted as adequate for the particular, and relatively safe, type of mining illustrated by the copper and iron deposits of Michigan, but in precious-metal mining, which is more hazardous, the rate of dividend should be at least 10%, with the possible exception of a few orebodies of extraordinary uniformity.

This method, of course, ignores unprofitable mines. It is also inapplicable to prospects. On the other hand, the mere discovery of mineral on land may give it an immediate and taxable value, to be determined on a different basis, as is shown in Mr. Finlay's report. In the productive copper mines he had a relatively simple problem. For instance, in the case of the Wolverine, the records showed that during the preceding five years the necessary data were as follows:

Yield of copper per ton of ore	26.7 lb.
Cost of producing copper per pound	7.65 c.
Average price of copper per pound	15.60 c.
Profit during the 5 years	\$3,896,270
Estimated total future production of copper in pounds	80,000,000
Valuation of the mine	\$3,700,000

The Wolverine orebody represents an enriched portion of the Kearsarge lode, which consists of a layer of amygdaloidal diabase impregnated with native copper. The lode has a fairly regular dip of 40° and has been traced on its strike for 5 miles through a series of most productive mines. Mr. Finlay assumed, or "calculated with certainty", that part of the Kearsarge lode

will continue profitable to at least 6000 ft. in depth and that 60% of the lode-area within the known profitable length will be mined to that great depth, yielding an average of 16 lb. copper per ton. On this basis the lode would yield 70,000,000 tons of ore, in addition to the 20,000,000 already mined. And of the grand total he credits the Wolverine with 3,600,000 tons. He gets at this by taking the surface area covering the lode on its dip at 215 acres, and the thickness of ore at 12 ft.—for the stoping-width is remarkably regular. Estimating that the reserve of ore will last for 9 years, that the copper can be won at 8 cents per pound, leaving a profit (on a 14c. price) of 6 cents per pound, he obtains a total profit of $4,800,000 and a present value of $3,700,000.

In appraising the copper mines of Michigan, Mr. Finlay had no trouble in obtaining accurate data in regard to cost, for the books of the companies operating the mines were open to him. These companies are old and respectable; the technical management is first-class; any information required by an accredited investigator is given willingly and accurately. Mr. Finlay could have had no trouble in ascertaining the total cost per pound of copper. Then he had to make an estimate of the probable price of copper during the future life of the mines under appraisal. He decided that 14 cents would be fair, although personally inclining to believe that this was low. That was in August, 1911. Since then the price of Lake copper has been as follows:

Year	Average
1911	12.63
1912	16.56
1913	15.70
1914	13.61

His estimate needs no apology. He was making an appraisal for annual taxation; presumably, therefore, the valuations of the various mines could be reviewed from year to year and corrected in accordance with the rise or fall in the price of copper. If he had been valuing the mines for a purchaser, he would, by taking 14 cents as an average price, have been no more conservative than we should reasonably expect an engineer to be under such circumstances. In short, he is justified in the result.

As regards the life of the mines, Mr. Finlay could make no

personal examination in the time at his disposal; he had to examine the records, with maps and sections, assisted by the willing information of the managers. On this he could rely to a degree not usual in the examination of mines in private practice. The copper mines of Michigan are well developed, the character of the orebodies is well understood, the relative persistence of the ore has been ascertained. Indeed, the non-persistence beyond a known horizon helps the appraiser, who is not called upon, as in some regions, to give serious thought to dreams of unlimited continuity in depth. The length of ore likely to be extracted is, in most cases, determined either by the boundaries of adjoining properties or by exploratory work, for the intelligent mine-operator endeavors to ascertain these fundamental facts as soon as possible, in order to plan intelligently and to equip providently. Therefore I conclude that Mr. Finlay's estimates of "life" were so correct as to afford a safe basis for the appraisal required by the Tax Commission.

Turning to the similar effort at scientific valuation in Wisconsin, two years later, it will be found that Mr. W. L. Uglow was instructed by law to assess mineral land at the "full cash value" it would bring "at private sale". This was understood to mean "a sum of money which engineers and business men would be willing to pay for a property if they should have full knowledge of all the facts of past production and future prospects at their command." The lack of "full knowledge" in regard to future production is, of course, the crux of the whole matter; indeed, it is the one awkward factor, and for that reason it is usually pushed into an obscure background.

Conditions in Wisconsin are relatively simple. The owners of the land are mostly farmers, who lease the ore-bearing areas to mining companies. The latter test the ground by churn-drilling and then sink their shafts, preparatory to extracting the ore, which lies at a shallow depth, the maximum being about 250 feet below the surface. A royalty of about 10% on the gross output is paid to the owner as his rent or share of the earnings. He pays the real-property tax, as well as an income-tax on his rent. The orebodies have their greatest dimension horizontally; about 10% of the crude ore is left as pillars; the ore consists of blende,

galena, and pyrite disseminated in limestone; it is subjected to concentration, the concentrate being sold to the smelting companies. The properties are small, for the shallowness of the deposits does not compel concerted effort or big capital expenditure.

In order to get at a reasonable basis for valuing the zinc mines of Wisconsin, Mr. Uglow takes a "hypothetical zinc mine", built upon the figures obtained from eight properties; these figures in turn he reduces to weighted averages over a period of four years. This four-year life is assumed on the basis of local experience. Of course, a whole lot of other assumptions have to be made, such as the price of spelter, which is put down as 5.7, 5.4, 5.0, and 5.5 cents per pound for the four years respectively, although it is not clear why the guess should not be made uniform. Apart from the fact that the price of zinc is beyond the vaticination of any appraiser of mines, it is noteworthy that in the last stage of his valuation Mr. Uglow deducts 15% "on account of the absence of data for checking the assumed figures for grades of ore." If 15%, why not 51%?

Having constructed this hypothetical mine, Mr. Uglow applies it to ground "well drilled" and ground "poorly drilled at the outset." The present value in the one case is $168,117 and in the other $125,180 at the beginning of the first year.

Next he applies various systems of valuation to this hypothetical mine and arrives at the conclusion that the most suitable method for the zinc mines of Wisconsin is that of equated income. To ascertain the value of a mine, therefore, he multiplies the annual operating profit by 2.43, this factor having been determined by mathematical analyses on the assumption of equal annual profits and an average life of 4 years. He concludes that, as compared with the *ad valorem* method, this scheme has the advantage of being based on the estimated average life of all the mines, not a particular one, in the district; it is calculated on the actual profit of the preceding year, not upon an estimate of future profit; moreover, it is well adapted to taxation because it assesses a mine in accordance with its ability to pay, rather than its sale-value.*

* "Method of Mine Valuation and Assessment", by W. L. Uglow, page 68.

Again we face the fact that the valuation of a mine for purchase and its assessment for taxation constitute two different problems. The tax-gatherer's valuation is made annually, and can be revised annually, therefore it is convenient to base it upon the actual profit—not production—of the previous year. The future does not concern the tax-gatherer; he takes short views of life; it is his duty annually to collect a contribution to the revenue of the State in equitable proportion.

We shall leave him to his troubles, which are relatively small, for it is our purpose to discuss the valuation of mines for sale or purchase, which is a far more difficult problem.

In order to value a mine, that is, to determine the price at which it is a reasonable purchase, it is necessary to estimate its future profits. That is done in successive steps, ascertaining:

1. The average yield per ton of ore
2. The average cost per ton of ore
   (The difference between 1 and 2 is the "profit")
3. The tonnage available now
4. The tonnage likely to be available in future years

Each step demands skill and experience. The yield is determined by a careful sampling of the ore exposed in the workings, by comparison with past records, and by an estimation of the probable extraction in the mill or smelter. The metal contents as determined by assay do not represent the yield; to ascertain that it is necessary to know the percentage of extraction by the metallurgical method most suitable. Mines are bought sometimes on the expectation of applying increased skill to the extraction of the metals from the ore. The expectation may prove too flattering.

The average cost can be ascertained from past records, with corrections based upon any anticipated change of conditions. The anticipations may prove fallacious. The records may be deceptive. "Cost" is interpreted variously. Among British-owned mines, particularly in Rhodesia and West Africa, it is customary to give a figure for "cost" that omits many inevitable items of expense, such as head-office expenses, taxes, insurance, depreciation, improvements, recruiting for labor, even

development and prospecting. In some cases the omissions represent discrepancies of 30% to 40% from the actual cost, giving phantom profits highly useful for share-market purposes. The big mines of the Rand issue monthly figures of profits that are illusory because in the cost the Transvaal profit-tax is omitted, together with London expenses, income-tax, debenture interest, and additional expenditure on new equipment. The result is that the profits periodically announced are 30% more than the dividends. I have always argued* that the profit to the shareholders, who are the owners of a mine as conducted on the joint-stock principle, is represented by the dividends that actually get into their pockets or are lodged to their bank-accounts. To many persons some of the items, such as interest and taxes, seem beside the mark. The borrowing of money on debentures, however, usually represents a miscalculation in the original estimate of initial expenditure for development and equipment. As for income-tax, it may be said that it is only a matter of book-keeping, since the collection at the source obviates later payment by the shareholder. But the income-tax on a mine is a true (and most inequitable) item of cost, for in most cases it is a tax not on income but on the return of capital. Until a mine has redeemed its purchase price, its dividends are not income. A mine is a wasting asset.

Many blunders in valuation are made by engineers owing to lack of knowledge concerning the "overhead" expenses. Any sagacious appraiser of a mine that is to be placed on the London market, and to be managed from there, should add 10 to 20%, according to tonnage of production, to his operating or local cost, if he expects to make a forecast that will stand the test of future accomplishment. Indeed, the best school for the appraiser is last year's almanac; let him read the old reports and valuations of mines now approaching exhaustion. He will see how errors were made and how estimates were falsified. For example, the small additions to equipment made from year to year may seem a minor item. No allowance usually is made for rebuilding or replacing the existing reduction works, yet no mill or smelter remains intact for many years, if the owners

* "The Mining Magazine". Editorials, April, June, and July, 1912.

are progressive. Fires and other accidents will happen. Decay and destruction, wear and tear, are inseparable from machinery and equipment. For example, the cost of new equipment at the Bunker Hill & Sullivan mine, in Idaho, averaged 80 cents per ton during 22 years, on a total operating cost of $2.66 per ton.* Again, when I examined the Camp Bird mine in 1900 I found that Thomas F. Walsh, the owner, had extracted $2,535,000 worth of ore at a cost of $6.50 per ton. I estimated the ore assured at $6,000,000 and anticipated that the cost could be reduced to $5.25, in consequence of an improved equipment and larger tonnage of production. The mine more than fulfilled the expectations of productivity and profit, but the average cost was $10 per ton. The administration and general expenses of a London company proved more costly than I had anticipated, in comparison with the thrifty management of an individual owner. The reading of old reports shows that a post-mortem will give data more reliable than those obtainable from a diagnosis made while the patient is alive; unfortunately, old reports disappear, to the comfort of the profession, and exhausted mines cease to be interesting, except to the historian; therefore this source of guidance is not readily available to the student of the subject under discussion.

Turning to the question of tonnage. The ore exposed can be measured and an estimate of that which is partly exposed can be made with reasonable accuracy by an experienced engineer, that is, by one wise to the vagaries of various types of ore deposit. When, however, the next step is taken, namely, the estimation of ore likely to be rendered available in future years, as the result of intelligent development and exploration, the engineer faces a crucial problem and one that may render all his previous ratiocinations utterly futile. The test of science is prediction; the inability of the mining engineer to predict the continuity of an orebody suggests that the appraisal of mines is not a science, but an approximation based upon empiricism.

Attempts have been made to express the probabilities of ore-persistence by formulae. Some engineers allow for future

* "The Valuation of Mines", by T. A. Rickard. "Mining and Scientific Press", May 24, 1913.

prospects by adding a fixed proportion—from 20 to 35%, for example—to the ore already proved. Such short cuts are illogical. They constitute a mere surmise. Mr. H. C. Hoover has suggested that "the minimum extension of an orebody or oreshoot in depth below any horizon would be a distance represented by a radius equal to one-half its length".* This may apply to his special experience in Western Australia but it is dangerous doctrine, for, as he himself adds: "This is not proposed as a formula giving the total amount of extension in depth, but as a sort of yardstick which has experience behind it". Another writer, with less experience and therefore greater positiveness, has offered sundry elaborate formulae† for the purpose of expressing the probabilities of ore-extension in depth. These, apart from their academic interest, are interesting as indicating how many uncertain factors are involved in the calculation. They are useful as suggesting a line of reasoning, based upon the length and thickness of the ore-shoot, the number of levels already proved, and the patchiness of the lode within the ore-shoot. Indeed the methods of an actuary may be illuminating to an engineer, but the latter must realize that human life has been studied much longer than the distribution of ore underground, and that the eccentricities of human nature are better understood than the vagaries of ore deposition. Calculations based on a large number of guesses can only yield a guess. The doctrine of probabilities has been stultified in mining too often to allow of its being stated as a scientific thesis.

Having ascertained the tonnage of ore in the mine and the probable profit per ton, the engineer can say that the ore assured will yield so much money, while the ore likely to be uncovered will enable so much more money to be taken out of the mine in future years. How much then is the property worth?

While the estimation of ore in most mines is hazardous, especially in the case of rich precious-metal veins or lodes, it is a pleasant fact that in certain types of deposit the size and continuity of the orebodies are such as to minimize the variation of

* "Principles of Mining", by Herbert C. Hoover. 1909. Page 31.

† "The Finance of a Mine", by M. H. Burnham. "The Mining Magazine", June 1911. Page 445.

metal-contents to the point of relative uniformity of production over long periods. This is true, or has been true for many years consecutively, of the native-copper lodes of Michigan, the gold-banket of the Witwatersrand, the gold-bearing schist of the Homestake, the copper-pyrite lenses of Huelva, and the extensive chalcocite impregnations of Nevada, Utah, and Arizona. However, even in these cases, it must be confessed that, for purposes of appraisal, the knowledge now available has come at a late date; it has come in the wake of experience, not as the result of preliminary investigation. Moreover, it is not applicable to other mines in other regions, save at great risk. Most young mines—and it is young mines we must appraise, as it is young people that we must insure—cannot be judged on the basis of experience on the Rand or in Michigan. That is why engineers with local experience in particular districts so often fail in diagnosing mines in other districts.

We return to the question: what is a mine worth, given an estimate of future profits? We have seen Mr. Finlay's formula, based on 5% for interest and 4% for amortization. I have said that his return of 5% might do in the case of the copper and iron mines of Michigan, but it was too low for most mining enterprises. Mr. Hoover says that "the mining business is one where 7% above provision for capital return is an absolute minimum demanded by the risks inherent in mines, even where the profit in sight gives warranty of the return of capital".* With this, of course, I agree. Indeed, in most precious-metal mines 10% is not too much. On the other hand no figure can be stated as generally applicable. It depends upon the factor of risk, which varies in each case, not only as regards the continuity of the ore, but the capacity and honesty of the management. This feature of the problem has been well elucidated by Mr. Burnham,† who asks, and answers, the question as to how much a mine ought to pay over the standard rate of interest on gilt-edged stock. Besides the addition to cover "the yearly contribution for capital redemption", he insists that provision be made for "the risk of loss of either capital or interest". Thus

* Op. cit. Page 43.

† "The Mining Magazine", May 1911. Pp. 361-363.

by the time the engineer has made his estimate of the value of ore assured and the profit therefrom, he finds his figures blown into the air by this explosion from under his very feet. These final considerations regarding the rate of return on the purchase price of the mine afford divergencies so big that all the little refinements of measuring, sampling, and assaying are rendered pitifully inconsequent. If we take the standard rate of interest on national bonds as 3% and if we add to this another 4% for capital redemption, we are brought face to face with the decision as to what further percentage must be made to provide for the risk inherent in mining and the final risk involved in a particular mine. Suppose we agree on the third item of our enquiry and call it 3%, even then we have the fourth item to ascertain—and it is by far the most momentous in the whole of our enquiry. It may range from 0 to 100%.

Let me illustrate. Many years ago I examined a small silver mine in Boulder county, Colorado. The vein was narrow but rich. The ore-bearing ground was sampled thoroughly. The result was to show that $150,000 worth of ore could be extracted at a cost of $40,000, working through an existing adit, so that $110,000 could be earned. The owners were willing to sell for that sum, half cash and half in six months. The winzes below the bottom level or adit showed that the vein was poor and broken by faults. The prospects in depth seemed to me slim. I considered it a poor purchase, because the risk of the known ore yielding less than the amount estimated outweighed the probability of finding more ore in virgin ground. Even 100% per annum—that is, the return of the purchase price in one year, as was feasible in this case—was not good enough. The later story of the mine justified this decision.

In a recognized guide to these matters, namely, the "Report Book for Mining Engineers" by A. G. Charleton, an example of mine valuation is given. In this hypothetical case the property contains 704,000 tons of ore averaging $12 in gold per ton, making $8,448,000. Allowing for a recovery of $10 and a cost of $7.50 per ton, the profit comes to $2,464,000. The conditions specified are: (1) That the above profit is to be won over a period of 11 years, (2) the plant and equipment are to cost $183,700, and

to this is to be added compound interest for two years at 5% during the time of development precedent to profitable production, (3) the capital is to be redeemed at 2½%, and (4) the purchaser is to be allowed 20% on his money. Therefore the present value is $290,000. As if this were not drastic enough, Mr. Charleton shows that on a 40% return the present value would be $4. This *reductio ad absurdum* shows where these methods of valuation land. After taking great pains to sample the ore and equal trouble to ascertain the profitable metallurgical recovery, after having inquired thoroughly into the question of cost and made several solemn guesses at the persistence of the ore—having solved these preliminary problems, the engineer is to choose between 5, 10, 20, or even 40% as the rate of return required to justify the "investment".

The elaboration of any calculation should be proportioned to the possible accuracy of the factors involved. Otherwise it fares no better than the New Jersey farmer's method of weighing sheep. The animal is attached to one end of a fence-rail while a bag of stones is attached to the other end. First the exact centre of the unloaded rail is ascertained, then the sheep and the bag of stones are fastened at an exactly equal distance from the centre, or fulcrum, and a perfect balance is obtained. When all this has been done with painstaking care, the bag is emptied on a clear bit of ground and the weight of the stones is guessed. Why not guess at the weight of the sheep in the first instance?

Obviously, therefore, mines are not to be appraised on the basis of an investment. Whether iron or coal mines are so different from those yielding the precious metals, or copper, lead, and zinc, as to warrant a different treatment, I leave it for others to state. My own experience has been chiefly in gold and silver mining. In the case of gold, one factor, namely, the market price of the metal, is eliminated. Just now the price of the base metals is subject to abnormal fluctuations, but even in peaceful times this element of uncertainty is an essential part of the business. Some of the bigger copper mines have reserves so large and operations so systematic that the perturbing factors are apt to be forgotten. Promoters and brokers speak of

such steady producers as "manufacturing propositions", meaning that they are on an enduring basis. This, of course, is balderdash. A mine is a wasting asset. It has no goodwill; that exists in the management and is transferable to another mine, but it does not ensure the life of a particular property. The resources of a mine are not renewed; at some stage in its history they are under-estimated and conjectural, but that does not mean that they are increased; they are merely uncovered. The art of mining cannot be applied on scientific principles until two basic ideas are fully comprehended:

(1) A mine is a wasting asset.
(2) Mining is a speculative business.

To treat a mine as an investment, and to appraise it on that basis, is to ignore the cumulative facts of today and of other days. Mining is a speculation that can be made wise or foolish according as a man recognises the inherent risk and takes his chances accordingly. As a speculation it is highly profitable when conducted intelligently. The ascertainable factors are sufficiently numerous to place a premium on trained observation and the inferences therefrom are sufficiently valuable to give an advantage to men of intelligent experience. The unknown and unknowable elements in the problem will remain so numerous and so important as to involve a risk so large, and the chance of a winning so big as to stimulate the adventurous spirit of man.

Paper No. 152

THE VALUATION OF OIL LANDS AND PROPERTIES.

By

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INTRODUCTION.

In order to be in harmony with the international character of this Congress, it was the writer's wish to make this paper largely a symposium of opinions and data gathered from the various oil fields of the world. Unfortunately the outbreak of the war in Europe occurred before the work of collecting this data was well under way. As a result, this paper is a study of the subject in relation to the fields of North America and especially of the San Joaquin Valley fields of California.

These fields are of great importance if judged from the standpoint of productivity. Up to the end of 1913, the fields of the United States have produced more than three fifths of the total petroleum production of the world, the figures being 3,690,694,605 barrels* for the United States, and 5,189,027,477 barrels for the total production of the world, according to the United States Geological Survey, Department of Interior. In 1914, the preliminary figures of the survey give as a production of the United States 292,000,000 barrels, and it is estimated by a local authority that of this California produced more than 100,000,000 barrels, or more than one third.

Moreover, figures by the U. S. G. S. show that the possibilities of production of California fields are very great as compared with the rest of the United States, the total available oil in California being put at from one third to one half of the

* "Barrel" as here used as a measure of oil = 42 U. S. gallons = 8.33 poods crude = 0.1364 metric tons crude.

total available for the United States. The California fields present many varying degrees of value, of depth, of gravities of oil and of productivity of wells, and it is therefore hoped that the principles reviewed and suggested here for these fields will to a certain extent apply to the majority of oil fields the world over.

The title of this paper is "The Valuation of Oil Lands and Properties" and I have taken "oil lands" to mean undeveloped oil-bearing lands, and "oil properties" to mean such lands when wholly or partially developed. The valuation of undeveloped lands, indicated geologically to be oil bearing, means the hypothecating of a developed property, based on the geologist's report of the oil prospects of the land in question and on the history of adjacent properties. Therefore, the methods of valuation are the same in principle as for oil properties, only there are much fewer data on which to base conclusions.

The element of chance looms as large in discussing oil properties as in the kindred field of metal mining. There is nothing directly comparable with miner's "positive ore" or "ore in sight" in an oil property, because the oil bearing stratum is invisible. Oil, unlike ore, cannot be measured before it is produced. Moreover, oil, unlike ore, is migratory in character and the owner of the tract of oil land may be legally robbed of a great deal of the oil contained under that land by neighboring wells.

In practice, chance always operates on the optimistic side—perhaps luckily, since if no one wished to "take a chance", in the optimistic way, and every prospective investor could and did divorce his hopes from his scientific judgment, the flow of capital would be largely cut off from the petroleum industry, especially in the case of newly discovered fields. As a matter of fact, an investor pays so much for what his engineer considers practically proven and so much on the chance of larger gains.

It must be said, however, that there are elements of chance in metal mining which have no direct parallel in oil development. I refer to the frequently troublesome matter of change of character of ore in depth, leading to reduction difficulties which sometimes necessitate large expenditures of money for changing equipment.

Generally speaking, the operation of an oil property is simpler than most forms of metal mining, and this would lead to the belief that the valuation of oil properties should be simpler than that of mines. The difficulty lies in the fact that oil cannot, like ore, be even approximately measured before recovery. This robs the engineer of what is considered in metal mining the safest factor of his calculation. In lieu of this, he can use only the past production of adjacent territory, which is not so satisfactory.

Any valuation, either for transfer or for information for stockholders, is predicted on good management. The engineer may not be asked for recommendations, but his results will nevertheless reflect his ideas and judgment along these lines.

It is, therefore, necessary during every investigation to determine a campaign of development, on which will depend expenditure of capital, future rate of output and life of property. This plan of campaign is determined by many elements, and it will be taken into account when a study is made of each of these elements.

Investment in oil lands and properties has been considered more or less of a gambler's game, as has been the case with mining. An endeavor will be made in this paper to show that the tendency of the past ten years, especially in California, has been toward methods of valuation which put such investments on a more scientific and business-like basis, and also to show how systematic study of certain elements involved can lead to this result. I believe that investors in oil properties, in the future, will have at their disposal, through the employment of competent engineers, as fair an exposition of their chances of success as investors in mining properties, who are advised by our best mining engineers, now enjoy.

In a study of any type of properties there are several elements which must be inquired into very closely. They are:

The element of future price of oil,
The element of future production,
The element of future cost of development,
The element of future cost of production,
The element of geology,
The element of chance,

and various other factors which are local in their character. All of these elements have a bearing on any type of property. It remains for the engineer to determine which are the determining factors in each particular type, and in any particular case, and to spend his time and his employer's money on his investigations in the ratio of their importance to the property in hand.

METHODS EMPLOYED.

The owner of a partially developed oil property has, in determining the value of his holdings, the following problem: He has as his stock in trade a certain amount of recoverable oil in the ground—how much he does not know. He can sell this oil in the future for so much per barrel—how much he does not know. It will cost him so much per barrel to install facilities, i. e., wells for recovering this oil—how much he does not know, although he can approximate this cost. It will cost him so much per barrel to produce this oil—how much, he can, again, only approximate. About the only real peg on which to hang a price seems to be the settled production of existing wells, and this is probably why early in the history of the industry the so-called Pennsylvania Method of valuing oil properties came into being.

Pennsylvania Method.

As applied by some of the biggest buyers of oil land, this method is as follows: An oil lease is priced on the basis of a certain amount per barrel of daily settled production from wells on the property. This price varies with the price of oil at somewhere near the rate of $100 a barrel per day for each 10c. variation in the price of oil. The price for the lease must be such that money will be returned in, at most, four years. Undrilled land must be sufficient to hold production for these four years, taking account of the inevitable decline of the old wells. The buyer's judgment is used in regard to the following factors: Amount of salt water to be pumped, depth of territory, pumping costs, terms of lease, etc. As a matter of fact, cost of drilling to depth is often balanced by the fact that deeper wells are more productive. Wells must be six months old before their production is considered settled. The

price is based on net production to the operator. Besides a study of the run records of the property, the settled production is determined by a ten-day gauging test conducted by the intended purchaser.

Gulf Coast Practice.

Professor E. T. Dumble and Mr. William Kennedy have supplied the following information about valuation in the Gulf Coastal fields.

There appears to be no very definite method of arriving at the value of any oil land in lower Louisiana or Texas Coastal fields. In the case of new territory, or what may be called "wildcat" territory, when a well is started it is generally watched very closely by scouts of the different companies. When evidence of oil is reached, the various companies begin to take such leases as may be obtainable. This contest for leases naturally leads to the offering and paying of bonuses, some of which reach extravagant proportions. For instance, at Columbia, bonuses reached higher than $500 per acre for property some distance away from the well, and $20,000 was paid for leasing 45 acres within a short distance of the discovery well.

In the older and more settled fields, information relative to the depth to be drilled, average thickness and character of the sands is known and some calculations are made before purchasing. In the first place, the size of the lease is taken into consideration; then the number of wells already drilled and the probabilities of new wells. The age of the producing wells, with the production of these, is shown by actual gauging extending over a week or ten days. The character of the oil produced and its price are all considered and, in addition, the average life of the wells in the whole field, particularly if the field is an old one.

The usual prices paid under these conditions per barrel of daily production are: Spindletop at $200; Humble, in the old and settled field, $150 to $175, and Sour Lake, $75. In the case of new wells, little attention is paid to their production, beyond the probabilities of what they may settle down to as judged by what older wells may be doing.

Figuring, based on income or rate of interest on money invested, is little known in these fields. In general, the prevailing idea in this Coastal country is to get all the oil out as quickly as possible, without any thought of cost. No value is placed upon the land as land for any other purposes.

Up to within the last year, very little attention has been paid to geological information. More attention was paid to "mineral-rod men". Within the last year, however, the larger companies are beginning to employ geologists.

California Practice.

It seems that the Pennsylvania method of valuation was never practiced to any extent in California. In the first place, oil lands in that State are very largely in desert localities and are held either by the Government or by private owners, and are unused. The Government lands were obtained under the laws of placer mining. A great deal of land changed hands before much production was obtained. Moreover, there is great difficulty in arriving at a figure for settled production, as will be explained more in detail below.

Most of the early valuations in California were made on prospective worth, and prices per acre of undeveloped land were commonly much higher than was usual in older fields. Bonuses for leases were also at a high figure, although the royalty paid seems to have averaged from one sixth to one eighth, as in older fields.

The exigencies of the case therefore tended to develop a new system of valuating oil properties.

Comparison of Two Methods.

I will briefly compare the methods used in two of the largest valuations made in this State. This will illustrate, perhaps, the tendencies of the past ten years. The first of these was made in 1901 in the Kern River field, and the second is now being made of properties in several of the San Joaquin Valley fields. The valuation of 1901 was for the purpose of consolidating a great number of individual holdings and was made by a committee of three able engineers. The purpose for which the valuation was made necessitated only comparative figures, which robs the report of much interest. Following is a summary of the work.

Kern River Field in 1901.

At that time (1901) there were only 470 producing wells in the Kern River field, but the boundaries of the field were fairly well defined. A quarter-section near the center of the field was taken as an example of the best oil land. Its value per acre was assumed at so many thousand dollars, and the valuating engineers were instructed to express the value of all other properties in terms of this one. I presume that this unit value was fixed from actual returns from the quarter-section chosen.

The engineers found that the value of land could be shown by a series of roughly concentric circles about the approximate center of the field. The points on which emphasis was laid in placing these circles were, briefly, as follows: A careful measurement was taken for about 30 days of actual production of all wells, always taking into account, and allowing for, fortuitous circumstances which might be present in any particular case; account was taken of the age of the well and the nature of its perforations; the fact of its sanding up; whether or not the wells had penetrated all the oil bearing measures; whether the water had been properly shut off, etc. No money value was given to wells, but only to land. No money value was given to differences in gravity of oil (the range being only about 4° or 5° Beaume), but value was attached to light gravity as a factor in cheap recovery and handling.

Estimate of Saturation.

In fixing values, weight was given to depth of sands beneath the surface, drilling difficulties, thickness, productiveness of oil measures, distance to lower water-level, etc. Average thicknesses of sands were obtained by numerous cross-sections. Productivity of sands was determined, aside from records of production, by taking samples of sand and measuring the possible oil saturation and the residual percentage remaining after all free-flowing oil had been drained off. This record (to a certain degree) was considered to give a measure of the total quantity of possible extractable oil in the field. Only one half of the net oil sand was considered prolific; the remainder was considered barren, and this seems to have been the chief factor of safety introduced.

One acre of oil sand one foot deep was calculated to hold 1267 barrels of extractable oil, or about 16% of the volume of the container. According to the latest figures, given by the California State Mining Bureau, only a little over 1% of the volume of the container has been recovered to date, although there are now about 1675 wells in this field, as against 470 when the report was made. This comparison must be considered, however, in the light of the fact that the State Mining Bureau did not allow the above mentioned factor of safety of 2 in calculating on volume of the container. It will be noted that in this valuation emphasis was placed on the present production of the wells and on the future recoverable amount of oil as deduced from experiments with samples of the sand.

Valuation of 1914-1915.

The second valuation which I will outline is now being carried on by a committee appointed by the Independent Producers' Agency in California and involves some 150 companies. This valuation will occupy several months' time and a corps of engineers and geologists, about fifteen in number, are engaged on it at this date. This valuation is also being made on a comparative basis, but the values of each property are expressed, first, in money, and then these money values compared. Values are based on several assumed prices of oil, each producing a different value. It may be said that doubling the price of oil, from 50c. to $1.00, increases the apparent value, at least in some cases, by a factor of 4.

The Pennsylvania Method was considered and rejected as being inapplicable because of lack of data at the present time for fixing any barrel-per-day value to California production. In other words, the production is not considered settled enough for this method, which was reserved as a check.

The Saturation Method was considered and rejected, after concluding that the usual figure for total recovery is 5% of the container. It was rejected, first, because of the great known variation in the saturation of sands; second, because this method takes no account of increasing production costs, per barrel produced, as the flush production declines.

Production Curve.

The method adopted is based upon the assumption that the

wells already drilled on any property will decrease according to a constant decreasing ratio, this ratio having been established by the decrease of production in the past. A curve value is applied for the initial production of new wells to be drilled and decreased according to the typical curve. To each yearly production of the old wells is added that of the new wells drilled, thus obtaining the total future production of the property.

The method of producing this decline of production curve is described more in detail under "Future Production".

From this curve is computed the probable yearly production for each year of the assumed life of the property in question. The total yearly expenditures are then computed independently, regardless of production, since these expenditures are considered somewhat of a constant. Any additional plant or cost of development is charged to the year when this expenditure is assumed to be made.

Total expenditures are then subtracted from gross receipts and net receipts are thus obtained at varying prices of oil.

Present value of net future receipts are calculated on an interest basis compatible with the chance involved (this should be about 8%, according to many authorities).

Ten years is taken as a basis for redemption fund.

In valuing surface equipment, only that equipment is considered which can be given a salvage value and removed from the property without interfering with its present operation, such as drilling tools, warehouse supplies, livestock, etc. Other surface equipment is considered in the calculations of future expenditures, and its bearing on the valuation is indirectly considered through these expenditure calculations.

It will be noted that in this method of valuation emphasis is laid as follows:

(1) The production "history" of all available wells is used in calculating future yield

(2) Operating costs are computed from actual field figures, and not from past costs reduced to an average per barrel figure

(3) Present value of actual net receipts for each year of life are computed

(4) The method furnishes a basis of calculation which may be applied to any and all properties without prejudice, except that, in every case, geological data, fortuitous circumstances, etc., are fully taken into account.

It is evident that the method just described is far more detailed and elaborate than the 1901 valuation of the Kern River field, and it may measure the advance in the science which has occurred in the intervening thirteen years. The engineers who valued the Kern River field, in 1901, fully complied with their instructions, and in each case the valuation was done with the same degree of application and intelligence. The later valuation simply made use of the knowledge gained in the meantime.

Of course, in the case of the valuation of 1901, there was no "history" of production in the Kern River field for the valuators to use. For use in future cases, it is interesting to note that the curves of decline of production constructed by the Producers' Committee for the Coalinga, Sunset and Midway fields are strikingly similar—so much so, that if the Coalinga curve were used for the lower fields, the calculations based thereon would be incorrect not more than the other uncertain factors would warrant. The Coalinga field is about 90 miles from the Midway field and they are not in the same geological horizon.

PRICE.

Normal history of price of oil at the well for large fields seems to be: A good price when the field is opened; a decided drop during first flush production; a recovery, as the production settles down and handling facilities are perfected. This means simply the working of the law of supply and demand, complicated by handling facilities. Oil is now a necessity of civilization, and the factors which will control its price are the same in principle as for any other necessity. I will attempt to point out only those points having a bearing on future price, which are peculiar to petroleum.

Range of Price.

A study of the yearly average price of crude oil for the past ten years, taken from "Production of Petroleum in 1913", by David T. Day, shows the following variations, based on highest yearly average:

Appalachian. 1904-1913.		
Highest	$2.458	(1913)
Lowest	1.308	(1911)
Per cent variation	47.	
Kansas and Oklahoma.		
Highest	$0.97	(1904)
Lowest	0.364	(1909)
Per cent variation	63.	
Gulf Coast.		
Highest	$0.936	(1913)
Lowest	0.24	(1905)
Per cent variation	74.	
Lima-Indiana.		
Highest	$1.38	(1913)
Lowest	0.793	(1911)
Per cent variation	42.	
Illinois.		
Highest	$1.296	(1913)
Lowest	0.593	(1910)
Per cent variation	54.	
California.		
Highest	$0.554	(1909)
Lowest	0.245	(1905)
Per cent variation	56.	

Taking an average of the above variation in prices, without considering the amount of oil affected by each, we have as an average variation for the past ten years, in the principal United States fields, 56 per cent of the highest average yearly prices.

This seems to indicate a tremendous risk to be faced by an operator when considering the future price of oil, and yet, both lead and copper show about this amount of variation in the same period.

Future Range of Price.

That prices will probably not show this range in the next ten years may reasonably be inferred from the fact that facili-

ties for oil transportation have so largely increased and will still further increase. This includes not only the joining of different fields with tide-water by pipe lines, but also the construction of the Panama Canal and the increased fleets of tank steamers.

The decision of the British Admiralty to largely increase the use of oil for the Fleet, and indications that the United States Navy strongly favors its use for fuel, point to the conclusion that these authorities consider the future production of oil as dependable.* In other words, oil for fuel is now a staple, just as it has been for refining purposes, and the increase in transportation facilities should tend towards less fluctuation and, no doubt, better prices.

Estimating Future Price.

It is fairly safe to assume that world-wide distribution and consumption will more than keep pace with probable increase of production during the next ten years. Therefore, for the valuation of any particular property, the local factors having an influence on price are those which the engineer must particularly study. These are: (1) The quality of the oil; (2) future local markets and, in the case of fuel oil, its competition with other fuels; (3) the chance of large and sudden increase in production, locally; (4) the possibility of Government control of prices.

In California, the price of oil is fixed by the base price for fuel oil. An oil up to 21° Beaume is sold at the base price. There is a small market for strictly road oil at varying prices. Oils of gravity above 21° Beaume are sold at an increased price for higher gravities.

The true value of an oil, however, can only be determined by chemical analysis, since gravity is not a sure measure of its refinable content. It is a question whether or not a producer will ever be paid for the true value to refiners of his oil. I believe most authorities think this very improbable. Nevertheless, a chemical analysis should be made in the valuation of a property, for obvious reasons.

The history of oil shows that oil from new fields, being

* See "The Maritime Features of the Crude Petroleum Problem", Rear Admiral John R. Edwards, Bull. A. I. M. E., Sept. 1914.

of a somewhat new chemical composition, was usually undervalued for refining. The advance in refining technology has largely obviated this. Moreover, oil is now valuable for different refined products than formally. Gasoline content is now very valuable, where kerosene content used to be most important; and oil for fuel is still growing in importance, although the last ten years have seen such a tremendous increase in its use.

"Topping".

An attempt to realize on the real value to refiners of their oil has been made by California producers during the past three years, by installations of topping plants on the lease. The tops are sold to refiners, and the bulk of the oil, at slightly reduced prices, perhaps, is sold for fuel or road oil. The general opinion is that these plants will become of more importance in the future than in the past, because of the change in quality of oil being produced.

Prior to the opening of the Buena Vista Hills, Fullerton, Lost Hills and Bellridge fields, the gravity of oil in California averaged below 20° Beaume. Within the past three years, the average gravity has risen, and now about 60% of the oil produced in California is above 22° Beaume and contains much better percentages of gasoline, etc.

Competition with Other Fuels.

For oils which are primarily fuel oils, competition with other fuels fixes a limit above which the price cannot rise.

Electricity.

In comparison with hydro-electric power, the limit is not readily fixed. This is because of the increasing efficiency of electric transmission lines, due to the higher voltage used. An interesting commentary on the possibilities of competition of hydro-electric power is the introduction in oil fields producing fuel oil of many motor installations driven by electricity generated by water power 100 miles or more away. As a matter of fact, at current prices of oil, this power could be generated in the field at a lower cost, provided the life of the field were known to be long enough and the use of electric power wide enough to justify a large capital expenditure for an efficient generating plant.

Coal.

In comparison with coal, the limit price for oil is more easily fixed, since their uses are comparable, both being available for large or small steam generating units. Mr. M. L. Requa has commented on this subject, for the Pacific Coast, in his article "Present Conditions in the California Oilfields" (Transactions A. I. M. E., San Francisco, 1911), from which I quote the following:

> "Alaska coal can be landed at Puget Sound ports for approximately $4.00 per ton.
>
> "Assuming 3.5 barrels of oil as equal to one ton of coal, and oil at 50 cents per barrel at the well, its comparative cost with coal per ton delivered on Puget Sound would be $3.50; and with oil at 75 cents at the well, this cost should not exceed $4.20. At prices even in excess of this, consumers would not return to coal, owing to the many indirect advantages accruing to the burning of oil. Costs at other points depend entirely upon distance by sea. Assuming Valparaiso, Chile, as the southern and Douglas Island, Alaska, as the northern extreme, with oil at 60 cents per barrel at the well, coal must sell at $5.00 per ton at Valparaiso, and $3.50 at Douglas Island, in order to equal oil in fuel-value. This takes into consideration due allowance for interest, redemption-funds, depreciation and transportation. When the prices of oil are yet higher coal cannot compete, because the oil is so much more satisfactory in every way and has so many advantages, that the cost of coal would have to be materially less to induce the abandonment of oil. In view of the above statements, it is fair to assume that during the life of the fields there will be no fear of competition from coal until oil is selling above 75 cents per barrel".

Natural Gas.

Natural gas may be a very keen competitor of fuel oil. On the other hand, its occurrence coincident with oil lends an added value to oil lands. In California, it competes with fuel oil in Los Angeles only, to any large extent. Its value to the producer of fuel oil in a field where gas is plentiful is appreciable and must be taken into account as a secondary asset. Casing-head gas and, more recently, gas from lead lines can easily be saved and used on the lease in place of oil. The gasoline content of this gas should be determined, and if a sufficient percentage is present, saved for use or sale. The gasoline now

(1914) manufactured in California from gas amounts to 8,000,000 gallons yearly and is increasing rapidly. Gasoline thus manufactured in the United States in 1913 is given as 24,000,000 gallons. There are now about 21 gas compressor installations in California and there were 232 in the United States in 1913, and the revenue to oil producers is no mean amount.

Sudden Increase in Production.

Perhaps the most potent factor, and the hardest to determine, in price variation is a sudden increase in production locally. This occurrence has within the past year knocked the bottom out of oil prices in Oklahoma. During the past five years, it has repeatedly depressed prices in California.

The Lake View gusher, in Midway, added, in a night, about one third to the previous total production of the State, and kept this up for two or three months. No limited market for any commodity can stand an increase like this. After the Lake View, the advent of gushers of the 10,000-barrel type has again and again held down the market as consumption seemed to be crawling up on production in a satisfactory manner.

Predictions have been made during the past three years that the day of big gushers in California is about over, but they continue to "come in". There is a strong tendency now, however, to hold back these monsters and limit their output by choking. Nevertheless, in California, as well as in newer fields, this element must be carefully studied before an optimistic view can be taken of the question of future price effected by the normal decline of fields.

Legislation.

There is no doubt that Government control of prices, either direct or indirect, is a possibility of the near future. Pipe lines have already been declared common carriers in California. Whether or not they can be so operated, generally, in practice is a question for which there is no space for discussion here, though it undoubtedly affects values of oil properties through its influence on price. It appears to the writer that the nature of oil and its multitude of grades of varying value make its sale in the field to large marketing companies the logical and most economical method of distribution.

In Oklahoma.

The recent attempt on the part of the State authorities of Oklahoma to influence the price of oil is interesting and instructive, and I will attempt to summarize what has been done.

In April, 1914, the oil field at Ardmore, known as the Healdon field, began to produce a great deal more oil than the marketing facilities could handle. The same became true of the deep sand in the Cushing field at about the same time.

The price of oil was reduced by the pipe lines; producers took the matter up with the Corporation Commission and a meeting was held. It was termed a ''hearing'', but it was really a mass meeting of producers, pipe-line companies, refiners and the Corporation Commission. Throughout the summer, several of these meetings were held.

In the April meeting, partly by virtue of an order attempting to prevent the production of oil to be sold at less than 75c., and partly, and largely, through agreement among the producers and pipe-line companies, the price was fixed at 75c. for the Cushing field and 50c. for the Healdon field—the quality of the latter oil being lower.

The Corporation Commission began at once attempting to control production, to the end that the oil be not wasted and the market be not depressed. This conservation effort was to an extent successful, but all the time the production increased and a great deal of oil was run into storage. At the April meeting, an agreement was entered into between the Corporation Commission, the Attorney General and the owners of pipe lines that no reduction in price would be made without first giving five days' notice to the State, as represented by the Attorney General and the Corporation Commission. Throughout the summer, the pipe lines continued to take oil almost up to their capacity at the then price. In September, however, the price fell to 55c. in drops of 5c. at a time at short intervals. The Corporation Commission, in view of the then enormous production and limited capacity of the pipe lines, consented to the several reductions from time to time.

While the attempt on the part of the Corporation Commission to control the price of oil was by indirection, the position of the Attorney General was that this could be done

directly. The Attorney General wanted to get the matter into Court, but the Commission and the pipe lines seemed to desire rather to compromise and get along amicably.

The long-maintained price of 75c. was rather because the pipe lines were being threatened by the Attorney General than because of any power of the Corporation Commission to make prices. While the authority of the Commission has at all times been in doubt, it appears that the entire legal doubt rested on the proposition as to whether or not the law, under which the Attorney General was insisting that the Commission had authority, did in fact confer the authority the Commission was attempting to exercise.

The Corporation Commission has been signally successful in enforcing the law that provides for pro rata runs from the field. This has been done through the employment of umpires of runs in the several fields where heavy production prevented the pipe lines taking all the oil. In December, 1914, only about 15% of the Cushing production was being run.

From the point of view of the independent producers, the activities of the Corporation Commission and the Attorney General by arguments, agreements and coercion have resulted in keeping the price of oil higher than was maintained on former occasions in Oklahoma when the local overproduction was so far in excess of the capacity of the pipe lines.

One of the Commissioners is authority for the statement that a pipe-line company at no time cut the price after it was fixed by the Commission. The price was always cut in a surreptitious manner by producers who had an excess of oil. In fact, while the pipe lines were still paying 75c. per barrel, some of the producers were trying to sell their oil in lots ranging from one to four million barrels, and were offering it at from 25% to 40% below the market price. These contracts were made out of the State and in a way that made it very questionable whether or not the Commission could stop it, and the Commission was forced in this way to permit the pipe lines to meet the competition.

Proposed Conservation Bill in Oklahoma.

At this writing a bill has been introduced in the Oklahoma Legislature, the first and second sections of which indicate the

broad influence of possible future legislation on oil production and price. They are as follows:

> "Section 1. That the production of crude oil or petroleum in the State of Oklahoma, in such manner and under such conditions as to constitute waste, is hereby prohibited.
>
> "Section 2. That the term waste, as used herein, among other things, shall include economic waste, underground waste, surface waste and waste incident to the production of crude oil or petroleum in excess of transportation or marketing facilities or reasonable market demands. What shall constitute waste, under the foregoing definition, or any particular case, shall be a question of fact. The Corporation Commission shall have authority to make all reasonable and necessary regulation for the prevention of such wastes, and for the protection of all fresh water strata and oil and gas bearing strata encountered in any well drilled for oil".

The chances are that legislation will have a great deal more to do with the oil business in the future than it has in the past ten years. Its effect on price, if any, in fields threatened with overproduction will probably be of advantage to the producer.

The control of prices by strong marketing companies is of course possible and natural. When these companies control large areas of highly prolific land, they are indeed in a commanding position through their power to increase production at will by vigorous drilling.

FUTURE PRODUCTION.

Given a fair estimate of the future production, except for the element of change in future price of oil, the task of valuating an oil property is reduced to a comparatively simple matter. In this estimate of production are involved all the unknown factors of the problem, except that of price. Oil production is like history; the only reliable forecast must be made from a study of the past. Here is where the petroleum engineer is at a great disadvantage compared to the mining engineer, who, in partially or fully developed mines, can touch and measure ore to be mined in the future.

A study of future production depends on: (1) past and

present production of neighboring wells, and, (2) geological investigations, including thickness and saturation of sands. So great is the dependence placed by operators on present production as a guide to future production that, as pointed out above, perhaps the majority of transfers of leases in America have been made at so much per barrel of settled daily production.

Study of History of Production.

In California, the future production of a property is no less important than elsewhere. Dependence, however, is beginning to be put more on "past history" of production than on present settled daily production. This is, probably, because of the recognized unstability of production of most of our fields, both from unforeseeable causes and from "sanding up", etc. California experience, covering a large number of wells in the two largest fields, indicates that from 5% to 8% of the producing wells are "off" all the time.

A study of the past history of production and the careful attempt to apply data thus gained to a prognostication of future production is perhaps the most interesting feature of the valuation of their various properties recently undertaken by the Independent Producers of California.

Curve Method.

With the kind permission of their Valuation Committee, I will briefly describe the method adopted. In each separate unit of territory of the same general characteristics, a campaign was first undertaken for collecting all possible production data, both from properties to be valued and from neighbors. For each well or group of wells was determined: (1) Date of completion; (2) initial settled production; (3) average production for each year of life; (4) all other facts bearing on production, such as appearance of water, etc. From these records, by groups, curves were drawn representing the average decline of wells.

A general curve for the territory was then constructed. Figure 1 shows the form this curve assumed for half of one of the largest California fields, where geological conditions are very uniform.

The available data extended over 7 years only, but it was

assumed that the average life of the field would be far longer than that. In order to extend the curve, a study was made of the history of the largest and oldest group of wells available and an equation worked out for their known decline. This equation was used in extending the curve, with a modification after the thirteenth year.

This curve was applied to properties in the same districts whose records did not give sufficient data for individual curves, or whose land was insufficiently drilled or too recently drilled to provide records for study, it being only necessary to know the average daily production for the first year.

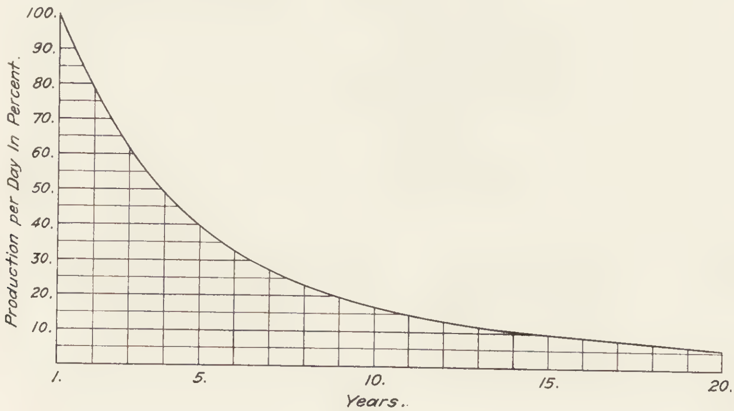

Fig. 1.

The curve for any property gave the total probable recoveries for wells then drilled. It remained to estimate recoveries for all future wells.

It is evident that a well drilled near a group of old wells will not have as great an initial production as it would have had if drilled in the same location when that location was virgin territory. Also, the longer the old wells have been producing and draining the territory, the less will be the initial production of the new well.

In determining the initial production of the wells to be drilled in the future, the following plan is under consideration: The total recoverable oil per acre is calculated by the production curve for those wells already drilled, which are assumed

to drain a certain number of acres per well. This total extraction is reduced to an acre-foot basis. The wells to be drilled in the future are then assumed to produce along the same production curve, the assumed or known thickness of sand beneath them being taken into account. In this manner their total production is arrived at and their initial production obtained from the typical curve.

Other Studies.

In studying past production, data from groups of wells drilled at approximately the same time are most valuable, since the factor of new production being continually brought in is a very disturbing element in the study of total production returns of a property. It makes no difference if these groups are made up from a single property or from wells across property lines.

Even though the records of a company are complete, in the case of valuation for transfer of property, a study of the present production of individual wells or groups of wells can be made with profit, especially if the product of all the wells of the property is mixed before gauging for shipment. It is desirable to know if each well or group of wells is of itself a paying investment. An average production is desired, but in California most wells produce at a very irregular rate. Therefore, the greater the number of gauges taken the better.

Gauging.

If individual gauging tanks are available, two at each well, careful gauging may give very satisfactory results, but even this method must be discounted from 4% to 12%. Evaporation, escape of entrained gas and line losses must account for this.

One value of individual well records is the fact that it enables the engineer to study the water content of the product of each well or group of wells, and a well showing an increasing amount of water is to be looked upon with the greatest suspicion. Determination of source of the water and how it can be shut off are matters of management.

Gushers.

Gushers, like an abnormally high assay, must not be eliminated entirely from calculations. If the average yield per

well of the property is to be taken, the yield of gushers must be reduced to the average, and this amount used for future estimates. The probability of getting another gusher on the property is one of the chances for gain which must be added to the estimated value of the property. The geological conditions have all to do with this. Past gushers are really a detriment to future production from nearby wells, but an added "chance" for large future gains.

Volume and Saturation Method.

In a great many valuations in the early days in California, the future production element was studied on the basis of recoverable content of sands, which may be called the method based on geological investigation. The factors are: (1) Thickness of sands; (2) saturation and gas pressure.

The average thickness of sands is almost always known, or may be assumed from logs of neighboring wells, but their saturation and the recoverable percent of this saturation are almost wholly matters of guess work. Of course, a uniform sand of rounded grains will hold the most oil. How much can be recovered depends on many factors—gas pressure, gravity, etc. A fair percentage of voids in a well-washed sand is from 30 to 35; the recoverable oil has been variously estimated as from 10% to 50% of the volume of these voids, or from 3% to 17½% of the volume of the container.

As a matter of fact, we have records of production which range from 1% to over 15% of the total volume of the container. In the latter case, a great deal of the shale between the sands was undoubtedly saturated with oil.

Kern River Recoveries.

The State Mineralogist of California estimates that the Kern River field, which has been producing for 14 years and is now on its decline, has produced oil to the extent of about 1% of the volume of the sands. Its total paying production (if present prices hold) will probably be not much more than 2% to 3% of the volume of the container.

The Balakhany-Sabunchy-Romany field, in Russia, is an example of large production, as a field. Up to 1913, it had produced about 12% of the total volume of the sands, and the field is not exhausted.

In the case of the Kern Rivèr field, the oil is heavy (about 15° Beaume). The sands are about 300 feet thick and the structure is a gentle monocline.

In the case of one of the best known high recovery cases in California (15%), the oil is comparatively light (about 22° Beaume), the sands about 120 feet thick and the property situated on the slope and near the crest of a highly saturated anticline.

It seems that the thickness of sand and saturation method is going out of vogue in California. It is very valuable as a check, however, and certainly limits the total probable recoveries of the field, if not of a property.

Figure 2.

Influence of Close Drilling.

Wherever loose sands form the oil content, a comparison of production records for individual wells almost invariably shows the great influence that neighboring drilling has on production. Figure 2 shows production curves for two wells a quarter of a mile apart. "A" well produces from about twice the thickness of sand as "B" well. They are about the same depth and are finished alike and were drilled about the same time, but there is only one other well within a quarter of a mile of "B" well, and this neighbor is about 500 feet distant, whereas there are five wells within 650 feet of "A" well. The

curves clearly show the superiority of "B" well as an investment.

These local diversities also emphasize how little average production figures for whole States, or even whole fields, may mean when applied to a particular property.

Water Intrusion.

After a reasonable future production has been calculated by any of the above methods, the element of chance enters in the form of water intrusion, either from wells on the property being valued or from neighbors' wells. Water in an oil sand, no matter what its source, comes like a thief in the night and will stop or cut down production of any well. This does not mean that the oil is driven out of the sand; it simply means that it is made unavailable, and if the source of the water is found and corrected, the oil will, in nine cases out of ten, come back.

Improvement in Cementing.

The engineer will be justified in looking to the future correction of water troubles with more confidence than the past would seem to indicate, because of the great advance made in the art of cementing. There is no doubt that there will be a great deal less water let into the oil sands in the future than in the past, and a great many of the old, incorrectly drilled wells will be corrected.

There are very few places where water foreign to the oil sands cannot be kept out by the use of modern methods of cementing. Furthermore, the collection of logs and histories of wells by water committees in each field is proving a great help for correct drilling. There is a general increase in efficiency in drilling methods, better pipe is being used, etc., so that the probability of recovering all possible oil from acreage not yet drilled is much greater now than it was 10 years ago.

COST OF DEVELOPMENT.

Costs Decreasing.

The cost of development averages a great deal higher in California than in the older Eastern fields, and it is higher in California today than it was ten years ago, owing to the pene-

tration of deeper territory. On the other hand, it averages lower today than it did three years ago, and it will be still lower in the future. This is because of the introduction and perfection of the rotary method of drilling, as well as improved standard or cable tool methods. Moreover, for the smaller operator the growing activity and reliability of drilling contractors is a God-send. In the Eastern and Mid-Continental fields, where experienced contractors are available and where drilling conditions are comparatively simple, the cost per well of future drilling may be figured very exactly by the valuating engineer. In the Gulf Coastal fields, where ideal conditions for rotary drilling prevail and where contracting is common but blowouts dangerous, the average cost per well is higher, but still fairly uniform.

High Costs with Cable Tools.

In the California fields, drilling costs reach their highest figure. This is partly on account of depth, but more on account of the difficulty of keeping open the holes drilled through loose and shifting formations interspersed with "hard shells". Until recently operators thought that these "hard shells" precluded the use of the rotary—as, indeed, they did preclude the use of a rotary developed and adapted only to the gumbo formations of the Gulf Coastal plain, where this system of drilling originated. Therefore, the cable system was universally used and developed to a high point of perfection, especially in regard to carrying long strings of casing through loose formations.

This development of cable tool drilling achieved two results—it made possible wells in territory previously too deep for development, and it made these deep wells enormously expensive. Derricks and rigs alone on 3500- to 4000-foot territory in the Coalinga field cost between \$3,000 and \$4,000. The equipment of tools and machinery used in drilling these wells cost as much as \$3,000 or \$4,000, and the wells themselves, up to \$75,000 for a normal drilling job.

Introduction of Rotary.

Meanwhile, in the Midway field and the fields in the southern part of the State, the rotary was introduced from Texas and Louisiana. It was imported primarily to drill the Buena

Vista Hills territory, where the enormous gas pressure and loose sands had defeated the cable tools. Incidentally, it became apparent that, on account of speed attained, the rotary was a cheaper method than the standard. Much improvement in the design and material of the rotary outfit has made it capable of drilling, with some exceptions, all the known oil territory of the State.

Contract Drilling.

The valuating engineer therefore may safely assume a lower average drilling cost for the future than is shown by records of the past. The increasing employment of contractors, moreover, renders his task easier. Contractors in California now charge from $4.00 to $6.00 a foot for wells 2000 feet and deeper. This, no doubt, sounds high for labor and use of drilling machinery only, but for the comparatively small operator it is usually the cheapest method. It relieves him of a large investment in drilling tools and machinery, fishing tools, etc., and most important of all, it relieves him of the loss in case of drilling accidents. In the Sunset-Midway field, a fairly accurate record, kept for many months, of the drilling done by several companies shows that of the total number of wells being drilled at any one time about 20% were "in trouble".

Drilling costs are usually figured on the foot basis. This varies in California from $3.00 to $20.00 a foot, depending on the depth of territory, etc., and including all charges. Inaccurate accounting has done much in the past to cloud these records. For instance, interest on money invested in drilling equipment and a correct proportion of overhead has seldom been charged against wells drilled on an operating property. Moreover, expenses incurred in "bringing in" a well and putting it in proper shape for steady production should be charged against drilling.

A check cost unit is the average cost of a drilling string per month. This varies in California all the way between $3,000 for cable tools to $10,000 for the rotary. Given the average daily footage drilled in a certain territory, the cost of a number of wells to be drilled can often be closely checked.

The cost of supporting installations varies largely with

the amount of oil produced rather than with the depth or cost per well. These installations, including pipe lines, pumps, tanks, gas separators, houses, etc., can be figured on an ordinary engineering basis and present few problems peculiar to oil production. This cost, in California, appears to be about 15% to 20% of the total cost of development.

It may be said that the period of excessive development costs has passed, due to improved methods of drilling and the advent of contractors; also, that the period of greatest variation in such costs has passed and that the valuating engineer will have a decreasing amount of trouble in future in calculating this element in valuation.

COST OF PRODUCTION.

This element of valuation may be considered fairly well established in the older fields of the United States. When the flow of oil into the well is steady, though small, and very little sand accompanies the oil, it can be taken out at a cost easily estimated. The increase of salt water has to be foreseen and it is one of the chances of the whole problem, as well as of this element.

Low Estimates in the Past.

Estimates of cost of production in California have tended to become larger during the past ten years. Some of the estimates made and figures given when the Kern River field first produced largely were very low (3c. or 4c. a barrel), even for a field noted for its low production costs. Estimates, now, for the larger fields are given as high as 40c. per barrel for average wells.

The difference in these estimates is mainly one of accounting. During the first years of production, little attention was paid to the question of deferred renewals. This expense has proven large, necessitating a heavy depreciation fund. Depreciation of wells and appurtenances (excluding land) and including the maintenance of production is now estimated by some authorities as equal to all other field charges combined and at figures as high as 12½c. per barrel.

Elements of Production Costs.

First of all, it must be clearly decided what shall constitute production cost and on what unit it shall be based. The usual unit is the barrel of oil delivered into the shipping tanks. A check unit is the cost per well producing. Very often groups of wells are taken as a unit, on account of the difficulty of segregating costs to single wells. It is evident that the cost per well is a very valuable figure in the estimation of future costs of production, since, with the decrease in output per well, this figure will vary far less than the cost per barrel.

Elements entering into the cost of production are now generally taken to be:

Field Costs:

Cost of pumping oil
Cost of repairs and renewals of wells
Cost of collecting, cleaning and delivering oil
Cost of repairs and renewals of installations and equipments
Cost of drilling to maintain production

General Costs:

Amortization of investment
General overhead expenses, taxes, insurance, etc.

Pumping Costs.

The cost of pumping oil varies with amount of oil pumped, depth of hole, tendency of wells to sand up, etc. Perhaps, within limits, the amount pumped has the least effect on cost per well and the greatest on cost per barrel. Depth of hole increases cost per well in a remarkably uniform manner, the monthly or yearly cost per well varying almost directly with the depth. This is one of those facts deduced from many examples for which there is no really adequate explanation. The tendency of wells to produce sand increases cost of pumping in two ways: It wears out pump, tubing and rods; and it decreases the net productive days of the well per month or year by those days spent in sand pumping or cleaning out the hole. Returns from a great many wells indicate that the average well in California produces only 90% to 95% of the time.

Usually, good records are kept of the cost of pumping

wells, and the engineer's first duty is a study of these records. In the case of gushers, however, especially large gushers, the cost of production is often assumed at almost nothing; this is far from the case. Experience has shown that, in California, cost per well with flowing wells is large, especially if the well flows at a considerable rate and with high pressure. These wells must be watched continuously. Deferred renewals are great, and the cost of caring for and handling the oil increases directly with yield. Gushers which break loose and flow wild for a short time are as often as not a direct loss. Large sums must be spent in caring for the flow and endeavoring to cap the well, and the owner is lucky if the flow does not cut out the pipe and ruin the well with water. Deferred renewals are also great in this case.

Repairs and Renewals.

The cost of repairs and renewals to wells will be low during the first part of the life of a well. Therefore past records of a comparatively new property are discounted by the valuating engineer. The most costly repairs are those of redrilling, which, of course, are, strictly speaking, renewals. Redrilling may be necessary on account of damaged oil string or on account of the breaking in of water. In the first instance, the history of surrounding wells is most important, as the oil string may "go bad" at any time during the life of a well, and the shifting character of the sands is the cause. Some bits of territory are possessed of a devil who makes a specialty of collapsing or breaking off the oil string.

Redrilling on account of water intrusion is a serious problem, because it involves the life of the water string. It can be foreseen in some cases—for instance, where an upper water is encountered which "eats out" iron or steel pipe. The composition and thickness of the water string and how it was cemented, if at all, have a direct bearing on its probable life and, therefore, a vital interest for the valuating engineer.

Collecting, Cleaning and Delivering.

The cost of collecting and delivering oil includes cleaning the oil, gauging it and mixing it to best advantage where gravity is a consideration in price. These operations all take place on the surface and are problems, which, with the exception,

perhaps, of cleaning the oil, present no special difficulties in estimating cost.

Previous to the past three or four years, the practice was to remove water and other foreign substances from oil by heating with steam and settling. This involves loss of gravity and volume through incipient distillation and, in the case of emulsions, also involves great cost for steam.

Recently, small refining plants have been put on the market, such as the Trumbull, which "top" the oil and return the heat from the tops to the entering crude, thereby cleaning it. Quite another method of dehydrating oil is the electrical process introduced about 1909 by Dr. F. G. Cottrell and Mr. Buckner Speed. The water in the oil, whether emulsified or not, is precipitated by means of high potential electricity without loss of the higher hydro-carbons in the oil. This process is, of course, dependent on availability of cheap electric current. This is given as an instance of the recent cheapening of certain operating costs which have their bearing on valuating properties.

The estimate of repairs and renewals of installations and equipment outside of the wells themselves is also a problem which requires ordinary engineering judgment, not peculiar to the oil industry. The depreciation allowed for this item must, however, be ultimately limited by the life of the oil measures themselves.

Maintaining Production.

Perhaps the most interesting and difficult factor in the estimation of cost of production is the expense to be incurred in drilling to maintain production. In the first place, it has not been the universal practice to charge this outlay to production at all, yet, once a satisfactory production is obtained, it must be kept up by new drilling, and this new drilling adds nothing to the income-producing capacity of the property and, therefore, cannot be considered a capital expense. The situation is similar to that in mining, where new drifts or gangways must be continually driven to enable the stopers to maintain a satisfactory output of ore or gravel.

The calculation of the amount to be spent in drilling new wells to maintain production may be based on the decline-of-

production curve already discussed, together with estimated cost of drilling and supporting facilities. It is evident that the greater the number of wells producing, the greater will be this cost; and that the cost will increase with the life of the property, since more and more wells are being drilled. On the other hand, the older a property, the less rapid will be the fall off in production from old wells. It will, therefore, be a figure of considerable variation if calculated in terms of cost per barrel of production. This, however, is the most convenient term to use.

General Costs.

The subjects of amortization of investment and of depreciation fund for deferred renewals will be discussed under another heading ("Financial Considerations"). General overhead expense, taxes and insurance are again subjects where principles not peculiar to the oil industry apply. It may be well to point out that fire risk is great in the oil fields. It is usually not applied to the wells themselves as apart from derricks, yet many wells are damaged when the derrick burns by the fall of the tubing to the bottom of the hole.

The Valuation Committee now at work for the Independent Producers' Agency of California assume that the monthly costs for production will ultimately reach a constant level, though the production will continue to decline, and, therefore, toward the end of the life of a property the costs per barrel will inevitably rise.

DEVELOPMENT PROGRAM.

It is superfluous to point out to oil men that the great difference between ore in a mine and oil in the ground is that oil may perfectly legally be coaxed by a neighbor from your ground into his, and thence up through his well and into his tanks, or vice versa; whereas, the ore in a deposit is there until the owner extracts it. This is a tremendously bad condition of affairs for the oil man, but oil will retain its characteristics, and so will operators, so there is little hope for betterment. It results in unnecessary drilling, over-production and low prices. It is one of the complicating factors in a campaign of development.

A program of development is outlined in order to arrive at a proper valuation of most oil properties, other than those fully drilled. This is especially necessary in valuations for transfer of property, because if line drilling by neighbors, or other considerations, make it imperative that a great deal of development work be done at once (perhaps during a period of depression in the price of oil), the money necessary must be furnished from sources outside of the income from the property, and this limits the amount and terms a buyer can afford to offer. Otherwise, the development work might be done from the revenues of the property and under the most favorable market, and other, conditions chosen by the owners.

Most leases carry a "drilling clause", which provides for a minimum number of wells to be drilled per year, or a minimum number of strings of tools to be kept running continuously until a certain number of wells are drilled. This is necessary for the protection of lessors, of course; but leases with a strict drilling clause, unmodified by making the drilling dependent on price of oil, have proved very dangerous for the lessee.

A development program is determined by:

1. Size and shape of property
2. Known physical properties of sands and of oil
3. Most desirable rate of output
4. Probable future price of oil

It is complicated by:

5. Drilling by neighbors along boundary lines
6. Probability of change in character of sands in different parts of the territory

Size and Shape of Property.

A small property surrounded by active neighbors must, of course, be drilled on the lines at a rate at least equal to neighbors' drilling. A neighbor who is loathe to drill, or who is willing to enter into a line agreement which precludes a drilling war, is a great asset to a property and should be so recognized.

An irregular shaped property is undesirable in direct proportion to the relation of the perimeter to its area, unless the owners or lessees are prepared to wage an aggressive drilling

war. On the other hand, a narrow strip may be very valuable, in that one row of wells can draw from both sides and thus a small acreage support a large number of wells.

In general, a large, compact property allows the most systematic and satisfactory development and also the most economical operation, since distribution of power, collecting systems, etc., may be economically arranged.

Radius of Production.

Given a piece of land, all of which is assumed to be oil-bearing, it is essential that the oil be recovered as cheaply as possible. This means that the minimum number of wells be drilled, compatible with thorough development. An effective radius of production must be fixed, that is, it must be determined how far each well will probably draw oil economically. It is obvious that, to win all the recoverable oil, the wells must be very close together. This is limited by the yield per well and cost of development. Many wells simply means speed in recovery at the cost of greater capital invested—and even this may be desirable in some cases.

In all fields, an economic distance between wells is arrived at in time. Observation and experience alone can determine it; but perhaps the engineer wishes to establish this economic production radius in a comparatively new field, and there are a few lines of inquiry that will help him.

In the first place, he can pretty safely assume, in a field where the oil container is a true sand, that the first boundary wells will be drilled too close together. Most observers believe that in California fields the oil could have been extracted with fewer wells drilled, and, hence, cheaper, and, as a matter of fact, with little loss of time. As a corollary to this, the writer knows of a fairly well drilled-up property which was shut down for five months during one year and for that year showed a total production equal to the year before, allowing for a slight natural decrease for age.

That traveling capacity of oil in true sands is very great is conclusively proved by the enormous yields of single wells or groups of wells, taking into consideration the thickness of the oil bearing sands. For instance, less than 60 wells on an area of 27 acres in the Bibi-Eibat field of Russia are credited

with a production of more than 58,000,000 barrels in twenty years. (Thompson "Petroleum Mining".) The sands here tapped probably average about 500 feet in thickness. If the voids in these sands are 30% of their volume and we assume the high extraction factor of 50% of the oil, it is obvious that this group of wells has already drawn oil to the extent of 15% of the volume of the sands from 100 acres.

Similarly, the Lake View gusher in the Sunset-Midway field of California produced upwards of 9,000,000 barrels of oil from only about 30 feet of sand, as reported by the drillers. On the same assumed values for voids and extractions, this well has drawn on 257 acres, and, with few exceptions, the wells subsequently drilled near the Lake View gusher bear out this conclusion.

The Lake View is on the slope of an anticline which showed high initial gas pressure. The oil produced was comparatively light and the sands were thin and loose—or "soft", in driller's parlance.

Another case, highly illustrative, is as follows: In the Kern River field, five years after a group of wells were drilled, 300 feet apart, one, in the center of the group, whose production had been from the first almost nothing, was re-perforated. It at once showed a production somewhat higher than the average initial production of the other wells in that group and has been a steady producer ever since. Here the oil sands are comparatively thick (about 300 feet), the oil heavy (about 14° Beaume), the gas pressure where the group was drilled almost nothing, and the field situated on a very gentle monocline.

The above examples may be taken as typical of California fields, and an economic production radius, to a large extent, is dependent on the characteristics shown.

Rate of Development.

It has been pointed out that, theoretically, on account of interest on capital investment, the fastest recovery and abandonment of an oil deposit is the most desirable. In any new field, this would produce a flow of oil detrimental to price, and there are a great many other practical circumstances which deter operators from following it out. Most often the desirable program is to get a production which will pay first-class

interest on the investment and maintain this production as long as possible. The facts that oil travels long distances in time, that production costs are low while gas pressure remains in the field, and that neighbors are drilling up their properties at certain rates, have a more or less strong influence on the program, usually towards acquiring a large production quickly.

On account of the risk involved, it is generally thought desirable to amortize oil property in California on a basis of not more than 10 to 15 years, even though the probable life of the field is longer. It seems reasonable to assume, therefore, that at least those parts of the property which are considered fairly established as oil bearing should be drilled up within these years. With a curve for decline of production and for initial production of wells, and a calculated output necessary to pay the required interest on the investment, a theoretical rate for future drilling can be tentatively established. It is influenced by all the questions studied above and also by financial circumstances, and with it are involved nearly all the elements of the problem of valuation.

The probable future price of oil is often the deciding factor of a development program. This is so obvious that it needs no discussion. It must be weighed against the loss of interest on capital invested but unproductive, or against a large initial capital expenditure for development, as the case may be.

Line drilling wars are the curse of the oil business. Lines must be drilled as protection against aggressive neighbors. The drilling program may be and often is absolutely so controlled for the first part of a development of a property and the rate of output largely so determined.

FINANCIAL CONSIDERATIONS.

An oil property is typical of that class of enterprise where exhaustion of principal in an assumed period is the controlling factor in financial calculations. In this it is entirely comparable to a mine—more especially to a base metal mine whose output is subject to price fluctuations. It is now recognized that there is no reason why the principles laid down for mines in regard to amortization of capital, depreciation, interest on

investment compatible with risks involved, discounting of deferred profits, present value of future ore reserve, etc., should not be applied in general as fundamentals for oil properties. These principles have been exhaustively treated by well-known mining engineers. In this paper I shall attempt to point out certain characteristics of oil properties which should be borne in mind.

Amortization of Investment.

Amortization of capital is entirely dependent on life of production, as with mines; but in mines this life is more in the hands of the operator than with oil properties. This is occasioned by the fact that oil is not yours until you have it in your tanks. Any oil property is to a certain extent drainable by neighbors. Furthermore, the appearance of water in the sands may render the oil unrecoverable, although the oil, of necessity, must be still there.

There are two kinds of "life" on which it is customary to base amortization, namely, life expressed in per cent of volume of oil extracted, and life expressed in years. The first of these provides for a depreciation charge against every barrel of oil extracted, calculated against the estimated assumed total recoverable oil. This naturally follows in a valuation in which future production is based on volume and extractable content of sands. Its weakness lies in the weakness of this premise and in the fact that it takes no account (except, perhaps, through an arbitrary factor of safety) of drainage by neighbors, water intrusion, etc. If a property is temporarily shut down for want of suitable market, while neighbors have satisfactory contracts, the actual depreciation of the property goes on, though not shown on the books by this system. The second "life", expressed in years, is based on the estimated life of the whole field and is not applicable to reserve lands not subject to drainage or damage by water. It naturally follows a calculation of future production based on the decline of production curve method. There is room for strong arguments for both conceptions of "life". Of course, they both amount to the same thing in the final analysis, and the question is simply as to which is the safest means of arriving at the desired end.

It is therefore advisable to amortize on a basis of a good deal short of the calculated life of the field, or property.

All capital invested falls in one of two classes: In land, i.e., in the oil to be produced, or in development. In some cases, of course, the land may be valuable for other purposes and this value may be considered its salvage value. Money invested in development must, of necessity, be amortized equally with the land, since there is nothing more worthless than a dead oil well.

Life of Oil Fields.

The life of oil fields presents the greatest contrasts. The Baku field, in Russia, began production in 1870, and in 1912 averaged 25 barrels per day per well. The profitable life of Spindletop in Texas was, perhaps, four years. In California, Kern River is the oldest of the large producing fields. It is fourteen years old and still a money maker. Nevertheless, it would be unwise to place the life of California property for amortization purposes at more than 15 years.

Whether amortization reserve from income shall be returned to stockholders or held in reserve is a question of policy. Many engineers seem to think that it should be held by the company in order to buy new oil lands as old lands are depleted. In other words, the life of the company should not be dependent on the life of the properties with which it began its operations. Mr. T. A. Rickard and others have pointed out the value of a mining organization, and I think the value of an organization is no less in the case of oil, so that if new fields are not provided this value is lost.

Deferred Renewals.

Depreciation on that part of the principal invested in land is covered by amortization. Depreciation on that part invested in facilities may be considered that loss in value not made good by renewals and repairs chargeable to ordinary operations, in other words, deferred renewals. It is based on inspection and experience. It is not, as a matter of fact, necessary for the facilities of an oil property to be kept up to their efficiency during the entire life of the property. An exception to this is, perhaps, a pipe line through which oil is delivered under heavy pressure.

There are usually three characteristic periods during the

life of a property. The first, during which all facilities are new and renewals will be light and production cheap; the second, during which expenses on account of drilling to maintain production and redrilling wells because of collapsed casing, water troubles, etc., will be heavy; the third, after the property is drilled, production is declining, and during which most facilities may be allowed to run down, paralleling the decline of production.

It would, therefore, seem advisable to accumulate a large depreciation reserve during the first part of the life of the property; in other words, a method should be adopted by which decreasing percentages should be set aside each year for depreciation.

(See a discussion of depreciation as applied to oil properties by P. W. Henry, Bull. A. I. M. E., January 1915.)

Treasury Document 1755.

A method of depreciating oil properties for taxation, which has occasioned much discussion, was advocated in Treasury Decision 1755 by R. E. Cabell in 1912. This is, in effect, a plan to depreciate the whole investment directly on the basis of the fall off in production. In the case of properties which have reached their maximum production, it is entirely suitable both from the stockholders' point of view and as a basis of taxation. In the case of a new property, unless each group of wells drilled during one year, their acreage and appurtenances, are carried as a separate investment in capital accounts, it leads to an impasse. This is so because an increase in production during any year would preclude depreciation for that year, whereas, of course, the principal, i.e., oil in the ground, was diminished during that year.

It is noteworthy that in T. D. 1755 the rule is laid down that "The cost of drilling and equipping new producing wells shall be considered additions to capital account; the expense of drilling dry holes may be charged to Profit and Loss".

From a legal point of view, T. D. 1755 is now obsolete; since, under the federal income tax law, the maximum deduction which a corporation can make on account of depletion of natural deposits must not exceed 5% of the gross value at

the well of the output for the year for which the computation is made. This is now being contested in the courts.

Surplus Fund.

In case the boundaries of a property are not drilled, a heavy expenditure may be forced on an oil company at any time for drilling to offset a neighbor's line well or wells. This expenditure cannot be foreseen, but it must be met at once or there is a sure risk of loss of oil through drainage. It is therefore wise to provide a surplus fund for such emergencies.

If a property is operating in gusher territory, the sudden failure of a single flowing well may mean a stoppage of a large part of the total production. This will also necessitate large expenditure for redrilling and drilling for production to take the place of that suddenly lost.

In general, it may be said that an oil company is, under conditions not uncommon, subject to large fluctuations in income, whether from change in price or production. It is also liable to sudden calls for large expenditures for developments not contemplated on the development program. Both these factors call for a surplus fund.

In view of the above an oil development enterprise seems to call for providing for:

(1) An amortization fund based on a very conservative estimated life of the deposits.

(2) A depreciation reserve set aside on the basis of decreasing percentages.

(3) A surplus fund for meeting expenses for emergency drilling.

Drilling new wells to maintain production, once a satisfactory output is acquired, may be considered, in effect, a charge against operating expense. It seems that this is the simplest view and the safest. Nevertheless, the money expended in these facilities is represented by a value on and in the ground which must be kept up and depreciated, and, in that respect, must be treated as an addition to capital account. This can well be done, however, and yet the cost of maintaining production in calculations of future profits, for valuation, may be distributed as part of cost per barrel of oil to be produced.

GEOLOGY.

The functions of the geologist in valuating oil lands and properties is directly comparable to his functions in valuating mines, and he is no less important in the former case. He is the precurser and co-worker of the valuating engineer. The value of his work increases directly with the newness of the field and with the complexity of the structure.

One of the greatest, and without doubt the most spectacular, features of the opening up of new oil lands in California during the past ten years was the activities of the U. S. Geological Survey. The Survey did some excellent mapping and brought the geologist and its work prominently before the investing public.

Within this period all large companies have employed geological staffs and these staffs have no doubt saved more than their pay, if only in advising where not to drill. The amount of money which has been wasted in drilling in positions where surface geology practically precluded success is enormous.

Petroleum Engineers.

There have appeared in the past few years a goodly number of "Petroleum Engineers", who are almost always, by training, geologists. In the early days in the West, so-called practical oil men tended to invade the field of the geologist. Now the tendency is for the geologist, under the name of "Petroleum Engineer", to not only report on his special subject but to overlap into the province which should be assigned to experienced oil operators. However this may be, no large company now contemplates investment in partially proven or prospective oil lands without first of all considering its geologist's report.

Functions of the Geologist.

This paper is not intended to include a discussion of geological facts and theories in relation to oil. I will only attempt to point out some of the geological points of study bearing on the valuation of oil lands.

The study naturally falls into two parts: (1) Structure and surface indications; (2) correlation of logs and deductions

therefrom. From these studies it is the province of the geologist to report on such facts as these: The reasonable probability of accumulation of oil and gas under the area in question; the probable thickness of the sands and their depth from the surface; the probable relation of water bearing strata to oil bearing strata; the relations of structure to oil accumulations—that is, which parts of the property are likely to be most productive; the probability of second and third oil horizons.

The geologist, as such, cannot go into the matter of difficulties and cost of development, nor can he reasonably predict production of wells, though he can collect data bearing on probable life of wells. The rareness with which geologist's predictions are entirely fulfilled is a measure of the risks of the business, especially in the case of undeveloped territory.

There is no doubt of the importance of domes and anticlines in the accumulation of oil and gas. The theory of these accumulations makes no difference to the oil producer; he is interested in knowing where oil has accumulated in the greatest quantity and in the most available form. Oil in anticlines seems to permeate finer grained formation than in flat strata or synclines, including shales and sandy shales. Two things favorable to production are thereby accomplished. The volume of the container is increased and the probable water bearing strata partially eliminated. Changes in dip affect oil accumulation in a manner similar to anticlines. They may increase accumulation at the expense of neighboring territory.

To determine facts like the above is the principal duty of the geologist, and unless these features are carefully determined, calculations on future costs may go greatly astray.

Study of Logs.

The study of logs, while not strictly a geological task, seems to be put, as a rule, in the hands of the geologist. This fact prolongs the value of a geologist to an operating company, and makes him a permanent member of its staff where the reserve lands are large.

There is an increasing tendency to map underground structure of a partially developed field from log data by the construction of "peg models", a sample of which may be seen at the Exposition (San Francisco, 1915) in the Mining Building.

From log data are determined thickness of sand, etc.; but this study of logs is greatly complicated by the personal equation. Often one driller will log a stratum as "shale"; another driller, the same stratum as "clay"; another, as "sandy shale". "Sand with shale" may be identical with "shale with a little sand"; brown, black or blue clay or shale are interchangeable, etc. The thickness of sands often varies greatly in logs according to the desire or judgment of the superintendent in charge.

Water sands are affected the same way. Their nature as reported in a log is largely influenced by the amount of water in the hole when the sand was drilled, whether or not a bailing test was made, how much mud was in the hole, etc. With the circular system, or the rotary system of drilling, it is very difficult to identify sulphur water, salt water, etc. In fact, a log takes its character largely from the system of drilling used. It is notorious in California that a rotary log next door to a standard log bears little or no resemblance to it, even when it is known that the strata are very uniform.

In valuation, the averages of well production for a whole State are misleading, and so may be the figures for the whole field in which the property is situated. The field, if large, must usually be subdivided into parts of similar structural characteristics before average figures are of value. This is a very important part of the geologist's work. It may be said that it is the geologist's function, primarily, to gather information and make his deductions ahead of the drill, and the engineer's, to compile his data from known results. As a matter of fact, the geologist who has taken up oil-field work is usually intrusted with both these classes of investigations.

It seems to be the increasing tendency to spend a little money for an investigation by a competent and reliable geologist before much greater amounts of money are spent in prospecting. How much weight shall be given geological evidence is a matter of judgment and very largely depends on the amount of other reliable data at hand.

APPLICATION OF DATA TO VALUATION.

It will be noted that all of the elements of valuation discussed above are variable factors, within wide limits. The

weight given to each element also varies greatly with the nature of the property under discussion, whether it be deep or shallow, largely drilled or virgin territory, etc. Add to this the great element of chance and at first sight it looks as if a shrewd guess were as good as the most painstaking investigation. Indeed, experienced judgment is perhaps the most valuable factor that can be brought to bear on the valuation question, and until recent years most oil lands were so appraised.

Nevertheless, the results of detailed study are now examined carefully as a basis for the exercise of experienced judgment. Indeed, an equation with two unknown factors may be written, and solved by trial, which will theoretically fix the value of oil properties which are near the beginning of their life. At least, by means of such an equation the weight to be given, in the final judgment, to each of the factors in valuation may be mathematically indicated with the exception, of course, of the factors of geology and chance. For example, we will take an undeveloped property consisting of 300 acres in a partially developed field:

Known or approximated factors:—

A. Yield per well, first year = 200 bbls. per day (net salable).
B. Cost of development per well = \$30,000.00.
C. Price received for oil, net = 50c per bbl.
D. Cost of production (including drilling to maintain production) = 30c per bbl.
E. Rate of interest demanded (profit) = 12%.
F. Amortization fund (10 years) = 8%.

Unknown factors:—

X = value of land.
Y = number of initial wells to be drilled and charged to capital account to establish satisfactory income—assumed, in this instance, as 15.

Then:—

$$(E+F)\ X + (E+F)\ (B \times Y) = A\ (C-D) \times 365 \times Y.$$

Substituting:—

$$.20X + .20\ (30{,}000 \times 15) = 200 \times .20 \times 365 \times 15.$$

Solving:—

X = \$645,000.00, or \$2,150.00 per acre for the land.

It will be noted that the most potent factors of this equation are the price received for the oil, the cost of production, and

the yield per well; and these are also the most variable and uncertain. The yield per well is, though indirectly, involved in net profit, through drilling to maintain production and from operating costs. Of course, everybody knew, in the first place, that yield and price are about the whole thing in valuation, and the only value claimed for the above study is that it forms a basis to work on and shows how much variation in any of the factors involved affects the value of the property.

For instance, in this case, a 10% advance in price will give a value to the land of $3,063.00 per acre, or a 42½% advance; and a 10% drop in price will decrease the value of the land 42½%. Likewise, a 10% advance in average yield per well will produce something more than 17% increase in value of land. A variation of 10% in cost of production shows a variation of 25½% in value of the land, and a 10% variation in cost of development per well shows a variation of only 7.5% in value of the land.

The price per acre arrived at must be varied according to the geologist's report and discounted according to the element of chance involved. The calculated value remaining in the property after 10 years must be added, in terms of its present value.

Of course, this formula is not applicable in its entirety to any oil property in existence; because such a property would have to be of such a size that, at the proper acreage per well and at the proper rate of drilling to maintain production, it would be just drilled up in ten years. It is offered only in illustration and as something to start from, and as a set of scales on which may be determined, in each particular case, the weight to be given the various elements of a valuation.

BIBLIOGRAPHY.

"Estimating Productive Capacity of Oil Lands", R. P. McLaughlin, Western Engineering, July, 1914, pp. 20-21. With records from the Coalinga Field.

"Basis for Calculating Special Excise Tax on Corporations", R. E. Cabell, Oil Age, March 1, 1912, pp. 2, 5.

"Taxation of Oil Properties", Oil Age, June 7, 1912, p. 1.

''Depreciation of Natural Gas Properties'', V. A. Hays, Progressive Age, vol. 30, pp. 787-8, Sept. 16, 1912. Paper read before Natural Gas Association.

''The Valuation of Oil Lands'', William Forstner, Mining and Scientific Press, vol. 103, pp. 578-80, Nov. 4, 1911.

''Valuation of Oil Wells'', Mining and Scientific Press, vol. 104, p. 284, 1912.

''Petroleum Mining and Oil-field Development'', A. Beeby Thompson, London, Lockwood, 1910. ''Production and Life of Oil Fields'', pp. 83-88.

''Factors in Cost of Oil Production'', William R. Jewell, Mining and Scientific Press, July 8, 1911, v. 103, pp. 44-46.

''Valuation of Oil Wells in the Appalachian Fields'', Mining and Scientific Press (Editorial), Feb. 17, 1912, v. 104, p. 284.

''Present Conditions in the California Oil-Fields'', Mark L. Requa, American Institute of Mining Engineers, Bulletin, Apr. 1912, no. 64, pp. 377-386. Discusses cost of production, etc.

''The Oil-Fields of Russia and the Russian Petroleum Industry'', A. Beeby Thompson, London, C. Lockwood & Son, 1904, ''Valuation of Oil Properties'', pp. 382-384.

''Depreciation as Applied to Oil Properties'', P. W. Henry, Bull. A. I. M. E., Jan. 1915.

''Treasury Rulings on Depreciation in Relation to Income Tax'', Engineering and Mining Journal, Vol. 97, p. 442, Feb. 21, 1914.

''Report of the Commissioner of Corporations on the Petroleum Industry'', U. S. Bureau of Corporations, Washington Govt. Print. Off., 1907. 2 v. See index of each volume under Costs, Depreciation, Profits.

''Comparative Costs of Rotary and Standard Drilling'', M. L. Requa, Bulletin A. I. M. E., February 1915.

''Estimation of Oil Reserves'', C. W. Washburn, Bulletin A. I. M. E., February 1915.

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SYMPOSIUM ON THE VALUATION OF COAL MINES AND LANDS.

Edited by

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VALUATION OF COAL LANDS.

By

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In considering this subject of "The Valuation of Coal Lands", one finds it much more of a problem than may appear from first thought.

When any specific problem is given to the Engineer under this caption, the particular thing desired is so clearly stated that he can begin at once to investigate the phase of the question with which he is charged, and thus at least his problem is clearly defined beforehand for him; but to write a paper on the subject, he must assume certain conditions or requirements before he can intelligently discuss the question.

We will therefore consider the subject from the following standpoints:

I. The value of virgin coal lands for investment.
II. The valuation of coal lands for operating purposes.
III. The valuation of coal lands for taxation purposes.

I. THE VALUATION OF VIRGIN COAL LANDS FOR INVESTMENT PURPOSES.

In the consideration of this question, it may be that the location of the property is such that the geological conditions

may have been determined in advance, through the Geological Reports of the Government, State, or private reports which are available for use.

If this be the case, the problem is somewhat simplified, in that the general conditions are already definitely defined, and much preliminary work is saved.

If, perchance, the property is in a location where there are no such reports available, one must first ascertain whether the land under consideration is in a coal bearing district and locate the geological measures, so that he may know the predominating influences which were at work when the coal was being formed and use this knowledge in determining what may be expected from the property under consideration, by comparison with the results obtained in similar seams, in other places, which are being operated.

The Engineer, after determining these questions, will proceed to investigate

1 The persistency of the coal seams
2 The character of the coal
3 The best systems of mining same
4 The transportation facilities, and the market for the output of the mines which it is contemplated to construct on and in the property, and whether the coal can be produced at a cost which will admit of a profit.

For, in the last analysis, if the coal cannot be produced and sold at a profit, the proposition will not be one that the conscientious engineer can recommend, irrespective of the quality of the coal that the property may contain.

1. As to the matter of the persistency of the coal seams, the extent to which this will, necessarily, have to be investigated depends largely upon the location and size of the property and upon what seams of coal the property carries. For example, if it should be the Great Pittsburgh Coal Seam that is under consideration, it would not require more than one or two openings or drill holes to determine quite accurately the thickness of the seams, for it is a well known fact that the Pittsburgh Seam changes but slightly, either as to thickness or character, except over great areas; and as a result, in such a case, a few

sections and samples would determine all that would be necessary to judge of the value of the coal measures. While if the property under consideration should be in the "Lower Productive Measure", in which the occurrence of the coal seams is very irregular, both as to quality and thickness, one will require very many more sections to be taken, more diamond drill holes put down, and the cores recovered and analyzed, in order to determine the approximate tonnage and character of the coal found to exist in the property and, consequently, its value.

2. In the character of coal will be found one of the principal items which go to make up the value of the coal land. It is very necessary to study the physical characteristics as well as the chemical composition of the coal, in order that the two prime commercial functions may be determined.

In order to ascertain these items of information, it is necessary that samples of the entire section of the coal seam shall be secured, so that chemical analyses of the whole seam or parts of the seam may be made. And in taking these sections or samples, care should be exercised to secure fair samples of the coal from the seam, such as would be produced in the actual mining operation; and to this end, any impurities which can easily be eliminated in the mining of the coal by the miner can be expelled or kept out of the test samples.

To test the physical properties a sufficient amount of the coal should be secured to make practical tests as to strength and best methods of handling and using the coal, so as to confirm the laboratory tests made thereon; and thus one may determine whether the physical and chemical compositions of the coal are such as will meet the requirements of the available markets.

3. The best system of mining the coal can generally be determined by actual working of the seam, yet it is possible to determine beforehand what systems will likely be successful in the district, by considering the roof strata, the floor or bottom conditions, as well as the physical characteristics of the coal. For example, if the coal is hard and the cleavage faces well defined, it will at once be determined that the coal should be worked on lines of the "butt and faces", and likewise the method—whether "room and pillar" method, the "long wall",

or the "advancing" or "retreating" systems—which would be advisable. Then, when the best method of working is decided upon, it is necessary to ascertain whether the requisite materials for such an operation are available for use, and, above all, the possibility of mining the coal at a reasonable cost, especially at such a cost as will successfully meet the competition encountered in marketing the coal. All of which, it will be readily seen, requires considerable experience before a person is equipped to be a successful appraiser.

4. The marketing of the coal is equally important with the other function just mentioned, and is determined by the proximity of other coal supplies, and whether the coal under consideration is better fitted for the requirements under which coal is used in the districts to which it is accessible. For instance, if the coal is low volatile coal, it should be so situated that the smoke ordinances of the cities and towns in which it would be marketed are such that the output of the mines would have a ready market in these cities and towns. The property would then be considered to have an advantage in the market. If the coal should be high volatile and low sulphur coal, such as would be well fitted for gas producers, and so located that this kind of business were available, then it would be considered satisfactory from a market standpoint. Then, again, if it should be good coking coal, and a market for coke were available, it would, again, be considered favorably from a market standpoint.

The marketing of the coal is, likewise, affected by the transportation facilities (as well as by the character of coal and cost of production), and it is necessary to consider carefully what markets can be reached and at what cost of transportation, as compared with those other districts which have coal that will meet the necessary requirements from a physical and chemical standpoint, as well as from the standpoint of cost of production. From this somewhat tedious consideration of interdependent conditions, it will at once be apparent that in order to properly fix a value on coal lands, it is necessary that the Engineer not only possess a good, general knowledge of the commercial aspect of coal mining, but also, that he possess a good knowledge of the geological conditions sur-

rounding the occurrence of coal, of the chemical and physical characteristics of coal, as affecting its commercial value, and of the best methods of mining any particular deposit of coal. It is a lack of qualification in the various phases of knowledge necessary to a fair valuation of property that leads to such a divergence of opinion on the valuation of coal lands for investment and other purposes.

II. THE VALUATION OF COAL LANDS FOR OPERATING PURPOSES.

The second main division of the subject will include all that has been said under the first head, heretofore considered —viz., The Value for Investment—and in addition thereto, a study of the particular property as to individual operation without any other adjoining property. Or, it may be that the property is the key to a larger block of coal (which could be best worked through the property under consideration), in its advantages in haulage, drainage, and cheaper cost of production, as well as in advantages of transportation, such as having one or more railroads at once available for shipment or in being able to make shipment by either rail or water. Also there arises the question of being able to secure and keep the necessary men for such an operation as is contemplated. Any or all of these factors add value to a property for immediate use as an operating property, over and above what might otherwise be considered a good investment property, and due allowance should be made therefor.

III. THE VALUATION OF COAL LANDS FOR TAXATION PURPOSES.

The third important division of the subject is one that has more difficulties to surmount than the first two phases of the question heretofore considered, and unless the mode of taxing should be based upon the amount of tonnage available in a piece of coal land, it is not often put up to the Engineer for consideration.

Let us examine some of the conditions that surround the taxing of coal lands and see how the valuation is arrived at for the purpose of taxation.

Let us examine, first, the form of tax imposed by the National Government under the new Internal Revenue law. Here the tax is imposed on the earnings of the coal company, instead of on the land. The coal company is not permitted to charge off the cost of the coal or coal land, but only 5% of the sale price of the coal at the mines, which in some places is fair enough, but in many places, such as the Pittsburgh District, this amount is not, on an average, much over one third of the cost of said coal, which, accordingly, would make the tax assessed by this method about three times what other persons owning other properties are required to pay, in so far as the value of the property is concerned.

Another practice is common in many of the counties of the State of Pennsylvania and in some parts of other States, viz., that as long as the coal is held by the farmer or owner of the surface land, no tax is levied against the coal at all; but as soon as the coal is sold and passes into the ownership of a coal company, then at once it is taxed on an arbitrary valuation fixed by the county commissioners or board of tax revision, if such exists. Thus, without changing any conditions, other than ownership, the property is made to produce an additional tax. Both of these cases are fundamentally wrong, and are permitted to exist on account of unfair politics and desire to cater to the socialistic demand of taxing corporations excessively.

Outside of the above condition, there comes what is, however, a commendable desire on the part of some boards of assessors to ascertain what is a fair value to place on coal lands, upon which to levy taxes; and we should all be willing to render service in assisting such boards.

In several counties in Western Pennsylvania, a fixed value (for coal land in a certain location) is placed upon a certain amount of coal land in connection with a going operation, and all acreage in excess of this fixed amount, which is called operating coal, is assessed at a lower value, usually about one half to three quarters of the value attached to the operating coal; and each year the amount of coal actually mined during the year is deducted from the cheaper or back coal. This general principle seems to me to be a fair method of assessing coal lands, independent of the question of whether or not the value

actually placed upon the coal is fair and reasonable. In this connection, however, I wish to call attention to a proposition which has been advocated of late, i. e., that of abolishing any tax on the coal land as such, and in lieu thereof to place a tax on the output of the mines on a tonnage basis. But even a casual investigation will divulge the unfair situation which would be produced by this system of taxation to the holder of only a small acreage of coal, in connection with a mine, as compared with a mine holding a large acreage of coal. The speculator or strong competitor who could afford to purchase large holdings of coal land and hold for a high, or even an exorbitant, price would not have to pay any tax on his holdings, thus, producing a very unequal system of taxation.

The system of placing an exactly similar valuation on all coals within a certain district, without taking into consideration the intrinsic value of the coal, is, likewise, unfair when used as a basis for taxation. But the operation of this system has, in many cases, been the result of lack of knowledge of what the fair value of such coal lands are, rather than from any intention of being unfair or with any purpose of benefitting favored owners of large areas of coal lands.

Where this occurs, it is evident that the services of competent persons, for valuing the coal lands, could be employed with profit to the entire community interested.

To ascertain a fair value for such coal lands, the factors which have been considered in determining the value of the coal lands for investment and for operation, taken jointly, as above outlined, should be applied; and that value, when determined, should form the basis for taxation, rather than some arbitrary, fixed value, which is usually as high as those holding the coal lands will permit to be placed upon them without litigation or appeal to legal determination.

In order to arrive at such a conclusion or valuation, it would probably require persons of more expert knowledge of the value of coal lands than is generally possessed by assessors; and while I realize that the person or persons who would be most capable of serving on such a commission would be selected from among those having a broad experience in investigating virgin coal lands, in the actual operation of mines,

and in the selling or marketing of the product of the mines; and while it might cost the districts who are levying the taxes some money for a report on the values within the district, yet, in the end, I believe that if this plan were adopted, it would give more general satisfaction, in that it would be more equitable.

Paper No. 154

THE VALUATION OF ANTHRACITE MINES.

By

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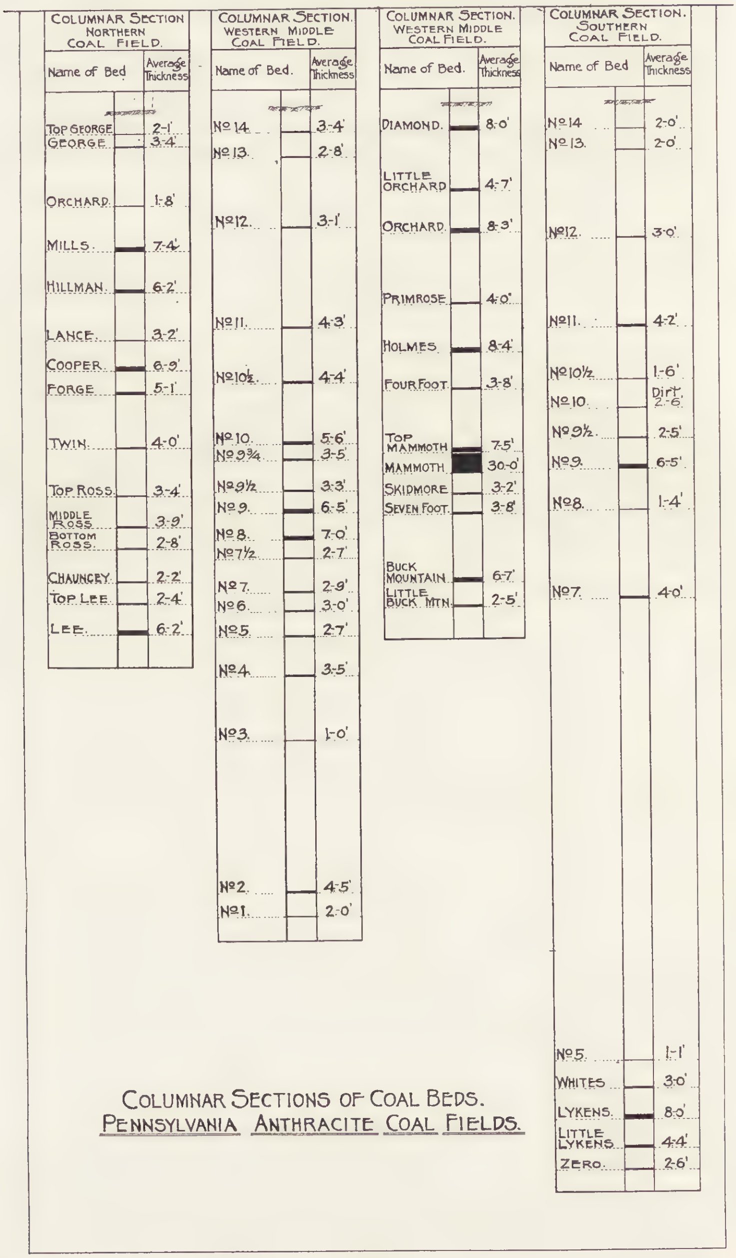
Anthracite, though occurring in many parts of the world, is mined principally in a small area in northeastern Pennsylvania, U. S. A. The anthracite region covers an area of about 480 square miles, estimated by Campbell to have originally contained about twenty billions of tons, as compared with two trillions of tons of bituminous coal in the country. The region includes the Northern or Wyoming Field, a single basin about fifty-five miles long, with a maximum width of about six miles. The dips are generally gentle, ranging from flat to about 20 degrees, except close to the crop and, occasionally, along anticlinals.

At least twenty-one workable beds have been identified, with a maximum depth below the surface approximating 2500 feet, and containing a total of from 60 to 70 feet of coal, at the best.

The "Lehigh" Field includes a number of small basins between the two main fields, and, by convention, also the Panther creek end of the Schuylkill basin. This field covers about forty-five square miles of coal measures and is notable for steeply dipping measures, often vertical, and for the great development of the Mammoth Bed, which in places is from forty to sixty feet thick.

The "Southern" Field stretches over 44 miles of territory, with a maximum width of about eight miles and an area of 165 square miles; this field has the deepest known measures, estimated to reach to nearly 4000 feet below the surface, with many steep dips and large beds.

The "Western Middle" Field is actually a branch of the



COLUMNAR SECTIONS OF COAL BEDS.
PENNSYLVANIA ANTHRACITE COAL FIELDS.

Fig. 1.

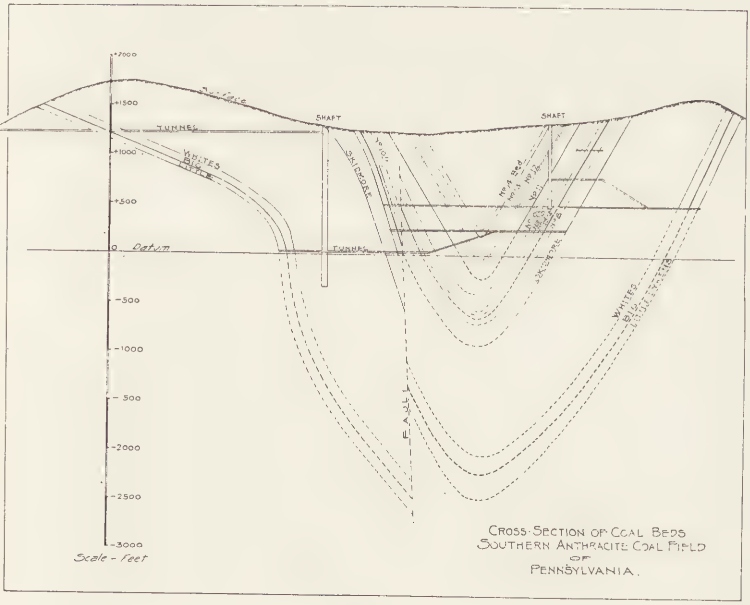

+2000
+1500
+1000
+500
0 Datum
-500
-1000
-2000
-2500
-3000
Scale - Feet
Surface
SHAFT
SHAFT
TUNNEL
TUNNEL
WHITES BIG
SKIDMORE
FAULT
CROSS-SECTION OF COAL BEDS
SOUTHERN ANTHRACITE COAL FIELD
OF
PENNSYLVANIA.

Fig. 2.

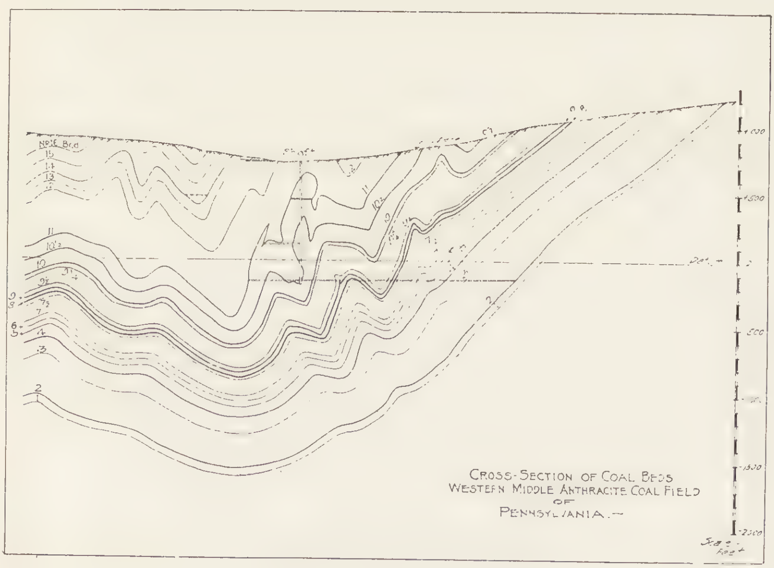

Shaft
CROSS-SECTION OF COAL BEDS
WESTERN MIDDLE ANTHRACITE COAL FIELD
OF
PENNSYLVANIA.

Fig. 3.

Southern Field, covering an additional 94 square miles, with a length of thirty-six miles and a maximum width of five miles. The deepest portion will probably not exceed three thousand feet to the bottom bed. Some twenty different beds have been mined in various portions of this region.

The problem of valuation of coal in the anthracite region is complicated by the rapid variations in the thickness and quality of the beds, by the numerous faults and still more numerous convolutions; the basins are traversed by endless anticlinals and synclinals, and within short distances good coal is changed to crushed and worthless dirt.

EARLY VALUATIONS.

While "stone coal" was reported in 1762, by the pioneer settlers of the Wyoming Valley, and used in a forge by Obadiah Gore, a Wyoming Valley blacksmith, in 1769, and as a domestic fuel by Judge Jesse Fell of Wilkes-Barré, Pennsylvania, in 1808, its commercial use—neglecting small shipments for forge use during the Revolution and unimportant river shipments, beginning in 1807—really dates from the formation of the Lehigh Coal & Navigation Company, in 1823, a combination of the Lehigh Coal Co., incorporated in 1792, and the Lehigh Navigation Company, incorporated in 1818.

As an example of the great value put on anthracite in those days, large areas were leased to the Lehigh Coal Mine Company, 1792, for two ears of corn per year, and the great bulk of the coal-bearing lands were patented by the State of Pennsylvania, from 1795 to about 1816, on payment of two to four dollars per acre. During the 40's and 50's of the last century, $50.00 per acre was a good price, which, by 1875, had risen to about $500.00 per acre for the best land. The value rapidly increased, until at the present time, $3000 per acre is considered only a fair price for good virgin coal land, and but very little of this has come on the market for many years.

ASSESSMENT VALUES FOR TAXATION.

Up to nearly 1890, the assessment of anthracite lands for taxation was at nominal values, irrespective of the coal contents; the surface valuation, with but unimportant additions

for the coal deposits, being used. At about this time, agitation for a more equitable division of the burdens of taxation led to material increases in the coal valuation and an effort to adjust this more equitably evolved assessment by the foot-acre of coal in the ground—usually reported by the owners or operators, occasionally under oath, as an average thickness spread over the area of the lowest bed. The valuation placed on the foot-acre base, while irregular and frequently objectionable, was not, up to 1907, confiscatory, and the taxes assessed were paid without serious resistance. In 1907, stimulated by a renewed newspaper agitation, great advances were made in the assessed valuation, still on the foot-acre basis, and assessments of from \$60 to \$100 per foot-acre were imposed; these were resisted in the Courts and are still (1915) in litigation, resulting in a condition of almost intolerable chaos. Despite Court rulings reducing the assessments to from \$40 to \$50 per foot-acre, the valuations have been continuously increased, until at the present time assessed valuations of from \$175 to \$300 per foot-acre are attempted to be imposed.

All assessment for taxation in the State is based on the laws of 1841 and 1842, under which the assessors are required to "assess, rate and value every subject of taxation according to the actual value thereof, and at such rates and prices as the same would bring at a bona fide sale after due notice"; and it has been ruled that the assessment value of similar properties must be equal. Under this law the Pennsylvania Supreme Court has ruled against foot-acre valuations (Report No. 229, page 465) and against royalty methods of valuation (No. 299, page 470), and has repeatedly declared that only valuations based on sales can be legally made. In the tax appeal cases tried, sales have been shown with prices varying from two or three hundred up to ten thousand dollars per acre, the smaller values for lands containing only relatively thin coal, or practically exhausted; medium values (from two to three thousand dollars per acre) for relatively small areas with normal coal contents, but unopened and generally not of sufficient area for separate operations; and extreme values, in a few cases, for going concerns, or for lands strategically located and thus having inflated values to particular purchasers.

The result of the long tax litigation has convinced most of the engineers and operators in the region that no equitable general basis for valuation, based on either sales, foot-acre contents or royalty values, can be found, and only in taxation of the output can a logical and equitable solution of the problem be reached.

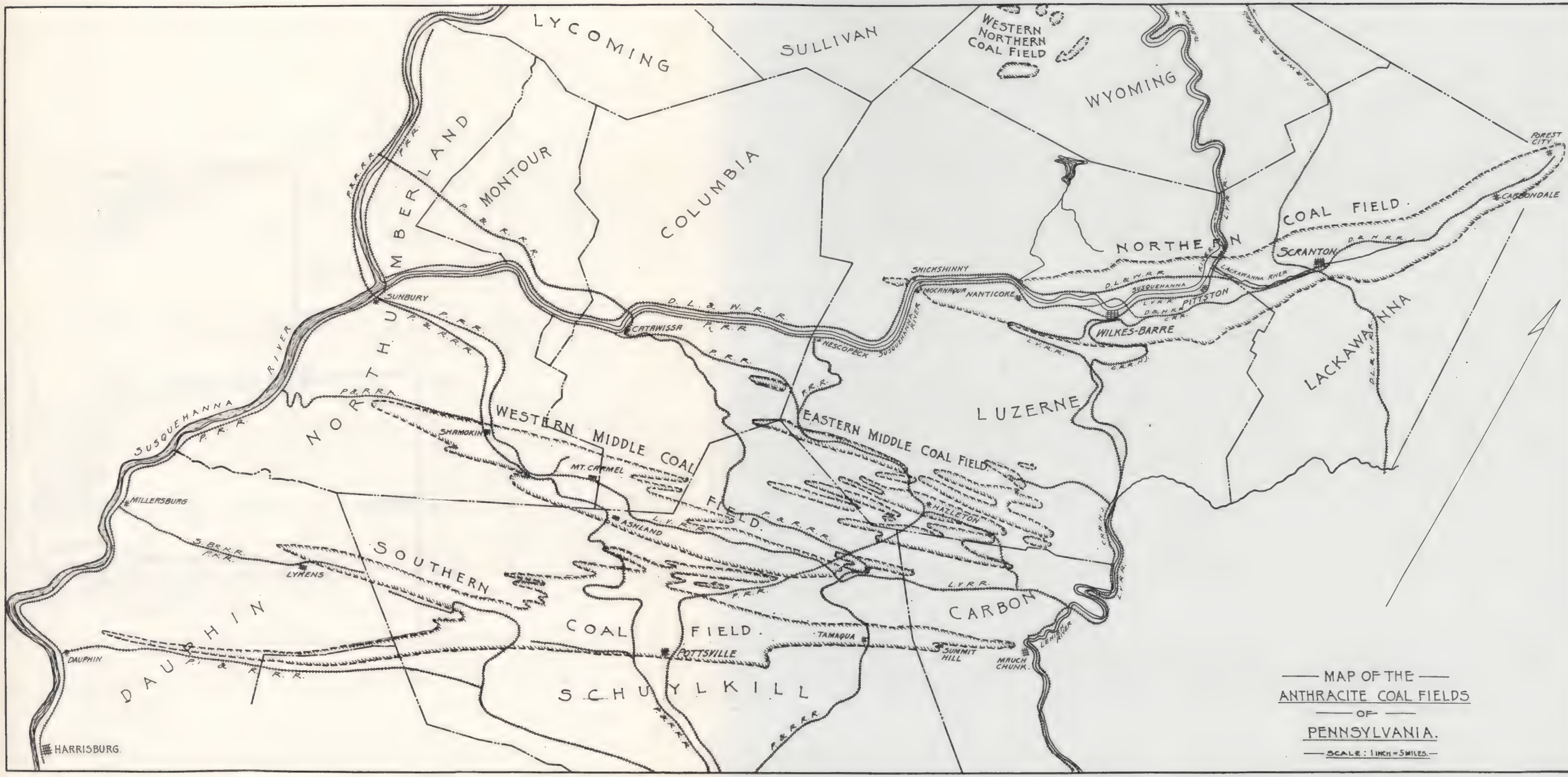
Further, taxation of coal reserves is opposed to all principles of conservation, by putting an excessive premium on rapid exhaustion and tending to the neglect and waste of all but the most profitable beds.

ROYALTY VALUATION.

From the general practice of mining coal on royalty, under so-called "leases"—really sales of coal in place, with payment as mining progresses,—the royalty method of valuation has come into use; the "leases" are usually for all the coal minable to exhaustion. Royalty rates have gradually risen from 8 to 10 cents per ton, for the prepared sizes only, required under leases made in the late 60's, to 25 cents per ton, prepared, in the 70's, when payment for the smaller sizes began to appear—usually, half of the prepared-coal rate for pea coal, and one quarter of that rate for the smaller sizes—and to from 40 to 50 cents per ton, prepared, with proportionate rates for small coal—averaging from 30 to 40 cents per ton for all sizes—in the middle 80's. This rate has since been generally maintained, except in rare cases, where as high as 65 cents per ton, all sizes, for coal susceptible of stripping or of exceptionally cheap mining has been obtained.

The "royalty" method appears, on first thought, to be eminently logical and proper, and presents, certainly, a very simple method of valuation; it has, however, vital deficiencies.

First: That the time factor is a controlling one in "royalty" valuation. To illustrate: Assume five exactly similar properties, each containing 2,000,000 tons of coal to be worked out, seriatim, at an average of 100,000 tons per year, and each paying 30 cents per ton royalty—an annual royalty paid during the mining of each tract of \$30,000. On the basis of present assessments, these would each be valued at \$400,000 and would pay



MAP OF THE
ANTHRACITE COAL FIELDS
OF
PENNSYLVANIA.
SCALE: 1 INCH = 5 MILES.
LYCOMING
SULLIVAN
WESTERN NORTHERN COAL FIELD
WYOMING
NORTHUMBERLAND
MONTOUR
COLUMBIA
NORTHERN COAL FIELD
SCRANTON
CARBONDALE
FOREST CITY
SHICKSHINNY
NANTICOKE
PITTSTON
WILKES-BARRE
LACKAWANNA
LUZERNE
SUNBURY
CATAWISSA
NESCOPECK
SUSQUEHANNA RIVER
WESTERN MIDDLE COAL FIELD
EASTERN MIDDLE COAL FIELD
SHAMOKIN
MT. CARMEL
ASHLAND
HAZLETON
MILLERSBURG
LYKENS
SOUTHERN COAL FIELD
CARBON
TAMAQUA
SUMMIT HILL
MAUCH CHUNK
LEHIGH RIVER
POTTSVILLE
DAUPHIN
SCHUYLKILL
HARRISBURG

Plate I.

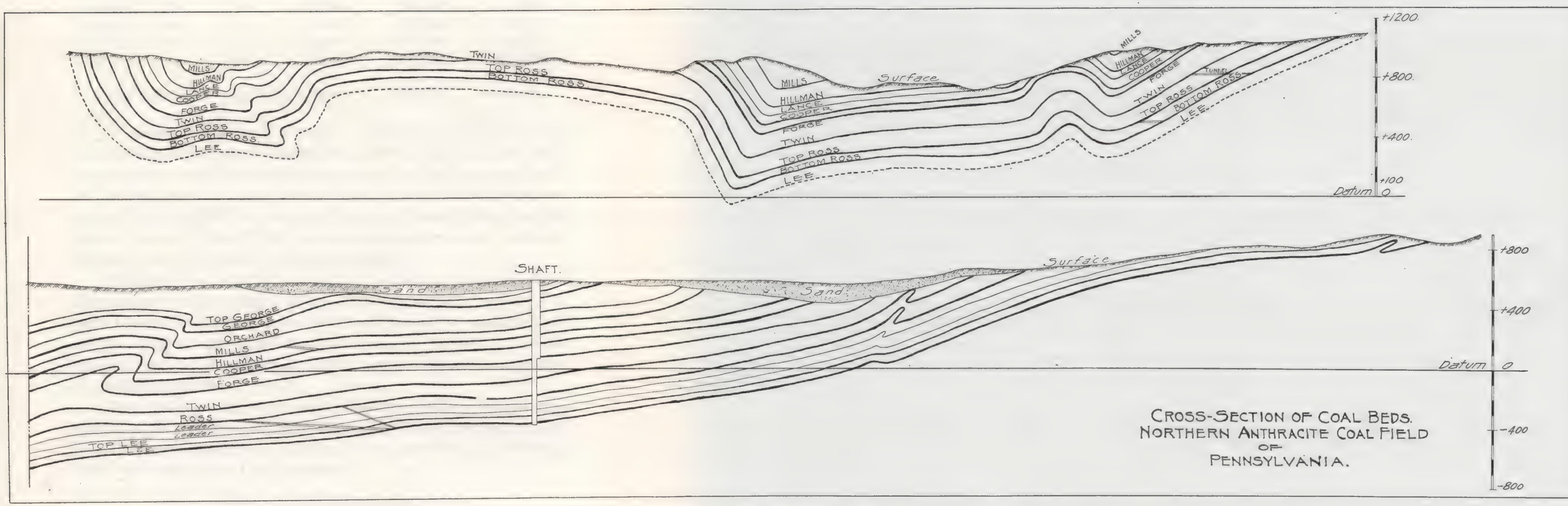

TWIN
TOP ROSS
BOTTOM ROSS
MILLS
HILLMAN
LANCE
COOPER
FORGE
TWIN
TOP ROSS
BOTTOM ROSS
LEE
Surface
MILLS
HILLMAN
LANCE
COOPER
FORGE
TWIN
TOP ROSS
BOTTOM ROSS
LEE
TUNNEL
+1200.
+800.
+400.
+100
Datum 0
SHAFT.
Surface
Sand
Sand
TOP GEORGE
GEORGE
ORCHARD
MILLS
HILLMAN
COOPER
FORGE
TWIN
ROSS
Leader
Leader
TOP LEE
LEE
Datum 0
+800
+400
-400
-800
CROSS-SECTION OF COAL BEDS.
NORTHERN ANTHRACITE COAL FIELD
OF
PENNSYLVANIA.

Plate II.

approximately $8,000 per year taxes, up to the average time of exhaustion. Their present value on a royalty basis, calculated at 6%, would be as follows:

Tracts	Start Mining Years	Complete Mining Years	Present Value of Royalty	Less Present Value Taxes	Net Present Value
First	0	20	$344,100	$ 58,880	$ 285,220
Second	20	40	107,360	110,120	—2,760
Third	40	60	33,550	126,100	—92,550
Fourth	60	80	10,430	131,080	—120,650
Fifth	80	100	3,250	132,550	—129,300
Present value entire property..			$498,690	$558,730	$—60,040

A present value for the whole property, mined at the rate of 100,000 tons per year, of $498,690; while if the same property were mined in twenty years, at the rate of 500,000 tons per year, its present royalty value would be $1,740,500, with a deduction of but $58,880 for present value of taxes, giving a net present value of $1,681,620, against a minus present value of $60,040, including taxes, for slow mining.

Second: The royalty method of valuation does not take into account the varying conditions of mining, the widely different costs of mining thin and thick beds, the influence of depth and pitch, the character of the coal, or the cost of development; nor can a proper royalty value be placed from study of prevailing rates.

Third: Valuation on a royalty basis is weak in its assumption that all coal has the same value, and therefore may result in a valuation bearing no relation to the profits to be received from the operation of the property.

VALUATION OF TONNAGE.

In the past, many coal valuations of important interests have been made by estimating the minable coal remaining and placing on it a flat value per ton, ranging from one to ten or even twenty cents; of course, such a valuation is a mere guess, based on nothing beyond the personal opinion of the appraiser, and bears no relation to the actual value of the property.

VALUATION ON PROBABLE PROFITS.

The average profit in anthracite mining, as deduced from the last census return by Mr. E. W. Parker, Statistician of the United States Geological Survey (Proceedings American Mining Congress, 1914), was, in 1909, about 20 cents per ton on actual operating costs; 72,215,273 long tons produced cost $134,-254,600, or $1.86 per ton, and brought at the mines $148,957,894, or $2.06 per ton. The capital invested was reported at $246,-700,000; so the average profit shows a return of a little less than 6% on the capital invested, without any allowance for depreciation of improvements or for depletion of properties. If but 5 cents per ton is allowed for exhaustion of properties, the return is reduced to about 4½%, from which a deduction must still be made for the amortization of improvements.

It would seem to be logical to assume that the value of a mining property will be best expressed by the present value of the ultimate product less the present value of the cost of its production, in other words, by a capitalization of the profits.

Unfortunately, such a method of valuation is exceedingly difficult, involving many and tedious calculations and long study of conditions, and while at the best but an approximation, with sufficient study it appears to give results more logical and probably more nearly correct than any of the methods previously discussed.

In general, the variables which must be determined comprise four classes of factors; labor conditions, prices, output (controlled by market and physical conditions) and mining cost.

In the anthracite region, as has been shown, the average margin of profit is so small that increases in labor rates have been, and must always be, accompanied by equalizing increases in selling price; hence, the factor of increasing wages—and the increase has approximated 45% in the last fifteen years—may reasonably be balanced against increasing prices, and the importance of the factor of "labor conditions" is thus minimized and may be disregarded without introducing probable serious errors.

The selling price of anthracite has been held practically

stationary, except for increases due to labor increases, for many years, the average for the last ten years, \$2.28 per ton f. o. b. mines, compares with \$2.39 for 1913. The principle controlling this has been enunciated by the late Mr. George F. Baer, in his testimony before the Interstate Commerce Commission:

> "The price of the entire supply of anything necessary for a community will be regulated by the cost of production of that portion of the necessary supply which is produced at the greatest expense".

As will be shown, the greatest expense of production is from thin and steeply pitching beds; and a sufficient portion of the necessary supply must be drawn from these to make negligible the probability of any material decrease of price. On the other hand, the constant competition of other fuels makes any material increase beyond that required to equalize increased cost of mining improbable. Hence, the present average margin over labor costs may, with reasonable safety, be assumed for at least some years in the future, and as the results of the earlier years have a preponderating influence on the valuation, the "market price" may be obtained with reasonable accuracy.

The market for the domestic sizes of anthracite has been shown to vary practically directly with the population of the consuming territory (Mineral Resources of the U. S., 1905, p. 658); for the years 1889 to 1891, it averaged 1.17 tons per capita, and for 1903 to 1905, 1.11 tons; and as the population is increasing faster than the output can possibly be increased, a constantly increasing market for the domestic sizes seems assured. For the steam sizes, the market, per capita of population, for the same periods has increased from 0.50 to 1.00 ton; and as the percentage of steam sizes available must decrease, owing to greater colliery demands for fuel with the extension both longitudinally and in depth of the workings, and the rapid reduction of the supply from the washing of the old banks, assurance may be felt of the continuance of a market for these sizes on a competitive basis with bituminous coal. The price of bituminous coal is more likely to rise than to fall, and can hardly fall materially, in view of the present small profits, shown by the last census (E. W. Parker, American Mining Congress, 1914) to be about 2½% on the capital invested, or about

seven cents per ton, to cover interest, amortization and depreciation, to say nothing of profit.

Then there appears to be an assured market for all probable production, the increase of which is much less rapid than formerly and which has apparently nearly reached its apex. The percentage of increase by ten-year periods has been approximately as follows:

Period	Production	Percent Increase
1823	6,951	....
1833	487,759	....
1843	1,263,598	159%
1853	5,195,151	313%
1863	9,556,006	84%
1873	21,227,952	122%
1883	31,793,027	49%
1893	43,089,537	35%
1903	59,362,831	38%
1913	69,069,628	16½%

Then, apparently, it is reasonably safe to assume that the present relation between labor prices and selling price can at least be maintained, and that as far as physical conditions permit, the output of any colliery can probably be gradually increased without overstocking the market; hence, the main variables to be taken account of in a valuation of probable profits are the cost of mining and the output of any colliery.

MINING COSTS.

Mining costs may be divided generally into cutting and loading coal (including normal development), general inside costs (timber, transportation, hoisting, pumping, ventilation, royalty and supervision) and outside costs (preparation, transportation, disposal of refuse, supervision, and general office costs). Of these, the inside costs have been found generally to vary directly, in any colliery, with the cost of cutting and loading, which, in turn, varies with the character, thickness and quality of each bed; while the outside cost is independent of the character of the coal.

In the valuation of an operating colliery, the costs of cutting and loading in each bed can be obtained, and an average future cost predicted from an average of the individual bed

costs, weighted in the proportion of each bed remaining; this cost may be, and usually is, far different from the present cost, as it will usually be found that much more than the average percentage remaining is being mined from the better and cheaper beds.

The principal varying factors in individual bed cost are thickness, pitch, depth, and character of coal.

Influence of Thickness of Coal.

The beds in the anthracite region vary from 2½ to 60 feet thick, and from nearly pure benches of large thickness to beds with inch layers of alternating coal and refuse; hence, no hard and fast formulae for the relation between thickness and cost are possible. In flat measures, the average of a very large number of costs, in different collieries, has shown that the lowest mining cost is for coal from six to seven feet thick, and taking this as a base, the average increase of cost for thinner beds approximates the following: 5 ft. thick, 10% increase; 4 ft., 25%; 3 ft., 50%; 2½ ft., 70%; and 2 ft., 100%.

Influence of Pitch of Coal.

The actual wages paid in pitch mining are practically the same as in flat mining; the difference in cost comes from the smaller yield of the beds. Taking the original contents removed, corrected for pitch, as a base, the yields for varying pitches approximate as follows:

Flat	82%	50 degrees	55%
10 degrees	80%	60 "	54%
20 "	75%	70 "	53%
30 "	68%	80 "	52%
40 "	61%	90 "	50%

Influence of Depth.

Sufficient mining at great depth has not yet been done in the anthracite region to give actual ultimate figures of yield under varying conditions. For first mining yield, Bunting's formula (Trans. A. I. M. E., Vol. 42, p. 236) gives for normal flat measures the safe percentage of removal for varying depths and thicknesses of bed.

P = Pillar width C = Chamber width
T = Total thickness of bed D = Depth in feet

$$P^2 + P\left(\frac{7}{3}T - \frac{DT}{300}\right) = \frac{CDT}{300}$$

Taking this as a base for a six-foot bed, the percentage of safe removal in first mining would be for less than 600 feet depth 60% ; 800 ft., 53.4% ; 1000 ft., 46½% ; 1200 ft., 44½% ; 1500 ft., 40%, and 2000 ft., 34.2%, with an unknown additional percentage for second mining.

In 1913 a committee of the chief mining engineers of the greater operating companies accepted as a basis of safe removal a scale based on both depth and thickness.

Bed Thickness	Depth Below Surface							
	0 to 500 ft.		500 to 1000 ft.		1000 to 1500 ft.		1500 to 2000 ft.	
	Percent Safely Removable							
	Flat	Pitch	Flat	Pitch	Flat	Pitch	Flat	Pitch
2½— 6 ft.	79%	75%	66%	63%	55%	52%	46%	44%
6 —10 "	75	71	63	60	52	49	43	41
10 —14 "	71	67	59	56	48	46	40	38
14 —20 "	68	65	56	53	45	43	37	35
20 —30 "	65	62	53	50	43	41	35	33

Influence of Character of Coal.

This must be studied separately in each colliery and each bed, with the general proposition that badly laminated beds or those containing soft or crushed coal are much more costly to mine than similar beds of pure hard coal; and further, that the yield from such soft or laminated beds is far less than normal.

Influence of Output on Cost.

A properly designed colliery should be equipped, in the broadest sense, for the particular output suited to its conditions, and variations from this will have a material influence on the cost of production; a decrease of output from the standard very rapidly raising costs and an increase reducing them, but not to so great an extent. By obtaining the operating costs of a colliery through a considerable term, it is usually possible to plot the various items of cost in relation to output in the form of a curve, for present conditions, then from this

curve, with the variation from the average of the cost in each individual bed, a curve of inside cost for varying output may be obtained for each bed, which, combined with the curves for outside and overhead costs, will give a curve for total cost in each bed for varying output. Then an average curve from these, weighted by the percentage remaining in each bed, may be obtained, representing the probable average future cost for all beds remaining. The bed cost curves thus obtained, further, show clearly, by locating a line of average sale price, the profitable and unprofitable beds at each output; and a curve of "profitable coal" may be drawn indicating the future probabilities of the colliery, mining only such coal as shows a profit at any particular output.

As an example of this, the diagram, Fig. 4, shows the separate costs in the five beds of an anthracite colliery, taken from actual practice; but taking averages of several beds in different collieries, assuming that there remains 500,000 tons in No. 1, 2,000,000 in No. 2, 1,000,000 in No. 3, 3,000,000 in No. 4 and 1,500,000 in No. 5 bed, the average future cost, assuming present conditions, is shown by the line marked "Average of all Beds", a weighted average of the bed curves. The distance of the curves from the vertical line of "average selling price at the mine", taken at an average of $2.75 per ton for all sizes, shows at once the probable profit or loss in mining any or all beds at any output. At the point where the bed curve crosses the selling price line, the coal in that bed becomes unprofitable, and from a weighted average of the profitable coal to the left of the price line, the line of all profitable coal may be drawn. Thus, at 400,000 tons output, the average cost for all beds would be $2.70 per ton, a profit of 5 cents on 8,000,000 tons or a total profit of $400,000; while at the same output, mining only profitable coal, the cost would be $2.33 per ton, a profit of 42 cents on 3,500,000 tons, or a total profit of $1,470,000, but with a loss of 4,500,000 tons of coal. On the right hand side of the diagram, the profitable tonnage for each output is shown, varying from 0, below 275,000 tons output, to the total 8,000,000 tons available, above 890,000 tons per year output.

While the curves for all collieries thus far tested take the general form of a hyperbola, the inclination of the axis and

the position of the apex depend upon the characteristics of the beds, the extent of the colliery and its equipment. The apex will usually appear at about the rated output of the colliery—in the diagram, about 400,000 tons per year—and the curves will approach a straight line at the limit of the colliery's capacity—on the diagram, about 550,000 tons.

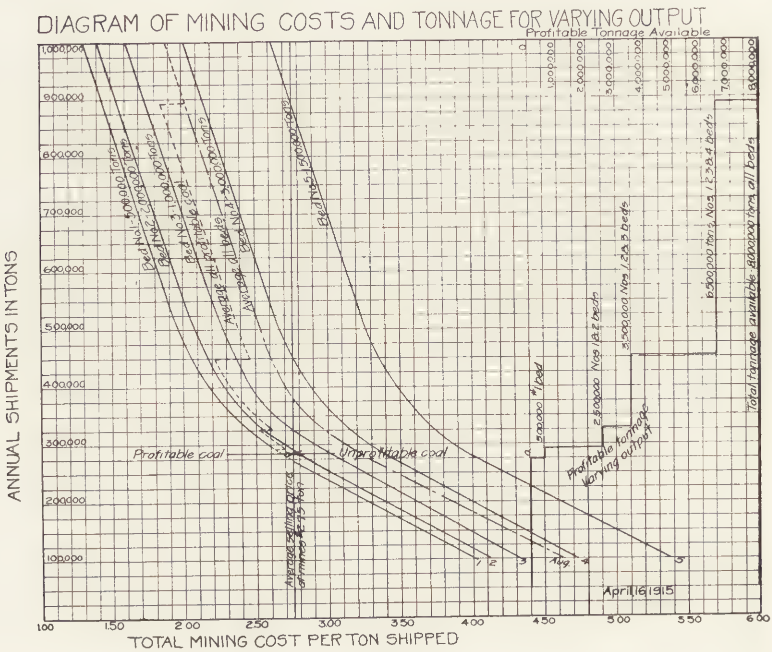


Fig. 4.

FUTURE PRODUCTION.

From the equipment of any colliery, its past history as to production, and the quantity and distribution of coal remaining, a fairly accurate prediction of the probable future production, decreasing as the colliery nears exhaustion, may be made. Plotting this probable future production in a curve and combining with the curves of average cost for each period gives a fair prediction of the probable future profits, which, discounted, give a present value for any colliery as a going concern. To such value must be added the present value of the surface lands and

remaining improvements at the exhaustion of the work; but with long-lived operations, such present values are small and the influence of errors not important.

TREATMENT OF IMPROVEMENTS.

It is evident that if a given virgin property has a gross earning capacity, with a present value, of, say, \$1,000,000, while the present value of the improvements necessary to produce such earning capacity is, say, \$400,000, then the present value of the property is not \$1,000,000, but \$600,000; hence, in a going property, the improvements and developments already made, except for their scrap value at the close of operation, may be neglected in a valuation based on future earnings; but any future improvements required to obtain the coal in place must be deducted, at their present value, from the present value of the earnings. In practice, it is impossible to forecast all such future improvements, but major improvements, as new shafts, new main tunnels, breakers, etc., may be taken into account in this way; and for minor improvements, an average cost per ton, based on past experience, may be added to the general cost.

The methods of valuation above outlined are of course only applicable to a mineral such as coal, the extent and quantity of which are susceptible of reasonably accurate estimation; and owing to the labor involved and the great cost of the necessary examinations, both of the physical conditions and of the books, are probably justified only in the valuation of important properties.

Paper No. 155

EVALUATING COAL PROPERTIES IN WESTERN CANADA.

By

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The most recent estimate of the content of the Western coal beds of Canada is 1,217,386,000,000 tons, which is classified as follows:

Anthracite and Semi-Anthracite	830,000,000	tons
Bituminous	282,313,000,000	"
Sub-Bituminous	847,821,000,000	"
Lignite	86,422,000,000	"

So enormous, therefore, are the fuel potentialities, that we must content ourselves with the consideration of such of these as are a present economic asset. And this it is the function of the Engineer to ascertain.

Some of the essentials which will determine the value of coal properties I shall enumerate. These essentials have reference, primarily, to virgin coal lands, but the remarks and deductions will apply equally to operating coal properties which may be under examination.

1. TITLES, ROYALTIES, ETC.

The title will be held under either freehold or leasehold, each of which may be subject to the payment of a royalty to the Government controlling them. This royalty may be varied at the will of the Government. At the present, it does not exceed 7½ cents per ton of coal mined and shipped, and some of the freeholds are exempt. Leaseholds from the Dominion carry an imposition of 5 cents per ton.

2. GEOLOGY.

The coal beds of Western Canada embrace periods from the Lower Cretaceous to the Tertiary. It is desirable to learn the geological age of the beds under examination, as this has its economic bearing.

3. QUALITY OF COAL.

(a) Sampling the Seam or Seams.

The history of the sample should be minutely recorded. A legitimate sample can only be taken from a clean face of coal, across its full width, or such part of its width as is deemed advisable to exploit. It is allowable, however, to eliminate those undesirable bands of rock, dirt, or ''bone'' which may be excluded from the shipping coal either during the process of mining or by later treatment. Hand specimens are misleading, and will serve only as museum exhibits, or maybe as items in determining classification.

Sometimes the seam must be entered upon for some considerable distance from surface influences before a fair sample can be obtained. This applies chiefly to lignite and sub-bituminous coals, but friable or easily weathered bituminous or anthracite also come under the same category. Where, however, the latter two readily withstand erosion and weathering, samples may safely be taken from the surface.

There are, of course, conditions met with where the seams do not reach the surface, in which cases the samples must be procured by boring.

The portion or portions of the seam chosen for sampling should be free from abnormalities.

(b) Analysis.

For general, practical purposes a proximate chemical analysis, with a determination of British thermal units and coking properties is, by most, considered sufficient. I would, however, go further and advise an ultimate analysis. Evolutions in the utilizations of coal are a natural outcome of competition and industrial exigency, and I predict that they will come to Western Canada in the not distant future. These will embody not only the fuller utilization of its heat units, but also of the by-products from coke and gas plants.

(c) Physical Properties.

As these have considerable to do with the ultimate marketing of the coal, they bear strongly on the value of the seam. The main features are: friability or firmness; weathering propensities; percentage of fines produced by comminution from handling and weathering; general aspect.

(d) Combustion Tests.

Practical tests under practical conditions give practical results.

4. SECTION OF MEASURES.

A log, with details of the cross-section of the seam or seams and nature of enclosing rocks, is essential in determining the scheme of mining.

The "dips" and "strikes" of the measures are part of this detail.

5. EXTENT OF DEPOSIT.

This is determined by figuring out the cubical contents of the seam or seams, so far as the stratigraphical features will admit, and no farther.

The deposit should then be classified as follows:

I. Seams Capable of Present Economic Production.

(a) Wholly. This is possible when the seam presents no extraordinary difficulties in the way of development by reason of entry, quality, flexures, faulting, intrusions, thinning or pinching out, ventilation, gas, haulage, etc.

(b) Partly. Where development can be prosecuted only for a certain distance into, or in certain portions of, the seam, owing to one or more of the difficulties indicated above.

II. Seams Capable of Future Production.

(a) Under Present Day Mining Methods. This may embody the "wholly" or "partly" subdivisions above, including also those seams which present drawbacks by reason of their location, accessibility, or other physical considerations, and cannot, therefore, promise immediate profitable returns, especially if competition is keen. They may be accepted as resources for development when favorable changed conditions of market and price would warrant their exploitation.

YEARLY STATEMENT

	Working days per year	Output per working day (tons)	Output per year (tons)	Acreage of leasehold	Cost of Plant and equipment	Depreciation of Plant and equipment	Cost of Mining per ton	Selling price per ton	Dividend in per cent of cap.	Receipts	Expenditure					Paid Up Capitalization on basis of 10% Dividend	Evaluation of Coal Rights	
										Total output sold at $2.50 per ton	Cost of Mining at $2 per ton	Lease Rental at $1 per acre	Depreciation and repairs	Dividend	Total		Total (Capital less cost of plant, etc.)	Per acre
1	175	1,000	175,000	1,000	$200,000	12%	$2.00	$2.50	10%	$437,500	$350,000	$1,000	$13,000	$73,500	$437,500	$735,000	$535,000	$535.00
2	115	1,000	115,000	1,000	200,000	10%	2.00	2.50	10%	287,500	230,000	1,000	10,000	46,000	287,500	460,000	260,000	260.00
3	175	500	87,500	1,000	200,000	10%	2.00	2.50	10%	218,750	175,000	1,000	10,000	32,750	218,750	327,500	127,500	127.50
4	125	500	62,500	1,000	200,000	10%	2.00	2.50	10%	156,250	125,000	1,000	10,000	20,250	156,250	202,500	2,500	2.50
5	150	250	37,500	400	50,000	12%	2.00	2.50	10%	93,750	75,000	400	2,500	15,850	93,750	158,500	108,500	271.25
6	150	150	22,500	1,000	40,000	12%	2.00	2.50	10%	56,250	45,000	1,000	2,000	8,250	56,250	82,500	42,500	42.50

(b) Under Future Mining Methods. These seams comprise those which can be erased entirely from the roster as present workable projects owing to adverse conditions of quality, dimensions, and other geological and physical features, etc.; and this is apart from the question as to whether or not they may be economically accessible from point of attack. The time may come when such beds of coal may be drawn upon, but it is not at all probable that this will eventuate so long as the more favorable conditions obtain among competing coals.

III. Seams to be Disregarded.

Included here are those which can show no practical value within a comparatively remote future. One cannot speculate on the distant future in the matter of heat-producing mediums which may then prevail, nor of the uses to which coal may then be put.

In estimating the amount of coal available in the seam or seams, due allowance must be made for waste and mining losses. Under prevailing conditions in Western Canada this amounts to from 15% to 50% of the total content. This waste will undoubtedly be reduced.

Under the caption "seams capable of present or future production" must also be included those seams whose product, being amenable to economical mechanical treatment and rendered marketable thereby, would otherwise remain unsalable so long as the demand can be satisfied at lower, similar, or even higher prices by cleaner and more desirable rival coals.

6. ACCESSIBILITY.

Economic access to the coal deposits is an absolute requirement, absence of which has militated against the successful operation of more than one otherwise excellent property. The cost of reaching the seam, transportation from the pit-mouth to the tipple, and then to its ultimate market, might preclude the possibility of successfully working the coal.

The chief factors to note are:

I. Transportation Facilities.

(a) Already available.

(b) Already projected.

(c) Feasibility of projected transportation from the standpoint of practicality.
(d) Distance to market.
(e) Freight rates.
(f) Cost of construction, equipment, maintenance and operation.
(g) Revenue to be derived, other than from the coal-carrying traffic.
(h) Effect on cost of coal per ton.

If required to be constructed and operated by the mines.

II. Mine Entry or Entries.

(a) Proximity to tipple and plant site.
(b) Strategical position with regard to system of mining advocated or adopted.

Where possible, outside inclines are to be avoided, especially if they be of great length. There is always trouble with inclines, due to climatic conditions, accidents, up-keep, and consequent increased cost.

7. PLANT REQUIREMENTS.

The plant is the vital link between the mine and the market, and its effectiveness should be the resultant of the requirements of both. Therefore, in designing the plant, or evaluating one already constructed, these features of mine and market will decide its actual fitness and commercial value.

8. METHOD OF MINING.

Certain maxims which are to be observed and followed in the development of a mine are:

Maximum output.
Minimum cost.
Maximum safety to men.
Maximum safety to mine.
And these are interdependent and inseparable.

An enumeration of the salients which govern the initial and future methods to be adopted is given hereunder:

(a) Elevation—above or below sea-level.

(b) Dips and strikes, with their variations.
(c) Nature and extent of folding of strata.
(d) Nature and extent of intrusions in strata.
(e) Nature and extent of faulting of strata.
(f) Nature and extent of other geological presentments.
(g) Thickness of seam, with included rock bands (if any).
(h) Structure of coal.
(i) Proximity of other seam or seams in same measures.
(j) Overburden.
(k) Surface conditions.
(l) Ventilation requirements, including gas and dust conditions.
(m) Liability to mine fires.
(n) Haulage considerations.
(o) Water disposal.
(p) Extent of workings.
(q) Cost of supplies and equipment.
(r) Market requirements as to quality.
(s) Market requirements as to quantity.
(t) Labor conditions.
(u) Legal mining restrictions.

9. COST OF PRODUCTION.

The cost of today can not be assumed as the cost of tomorrow; nor need the cost prevailing in any one case correspond with that obtaining in another, even in the same district, because never are the conditions identical. There are, however, certain temporarily constant factors, which, if taken in conjunction with the engineer's knowledge of the other details, will enable him to arrive at correct estimates.

I have purposely used the phrase "temporarily constant factors". The only really fixed factor is rate of return of capital. The others may be fixed for certain periods only. Some of the causes of varying costs are:

(a) Wages. This, for many years past, as we all know, has had an upward tendency; conversely, and this is statistically proven, as wages have increased, so has the producing capacity, per man, decreased.

(b) **Strikes.** A recurrent condition concomitant with coal-mining.

(c) **Supplies for maintenance and equipment.**

(d) **Unforeseen contingencies** arising in the strata, such as pinches, faults, folds, intrusions, gas emanations, etc.

(e) **Unforeseen contingencies** arising in the mines themselves, and any other adverse conditions of those items enumerated in Division 8 preceding [Method of Mining], or due to plant failures. This variable has wide limits.

(f) **Gradually increasing cost,** due to haulage, timbering, track laying, ventilation, water disposal, producing efficiency, and the various other odd problems which accumulate as development proceeds and the more distant portions of the seam are exploited.

10. PLANT SITE.

The suitability of a site for the erection of a complete plant affects profoundly the value.

The proximity of water is, of course, desirable, and the facilities afforded for miners' residences and other accommodations bear their part in the economy of things.

11. MARKET.

Unless the market be sufficiently stable to assure the continuous operation of the mine on the scale originally provided for, which of course includes the return of capital and dividends, the value of the lands depreciates correspondingly. It may be that the capitalization and bonded indebtedness are out of proportion with the potentialities of the market, or, again, it may be that the latter have not been taken advantage of to the full.

The chances of securing and retaining a sufficient market for any given property are affected by the competition of other coals, petroleum, natural gas, peat, wood and hydro-electric power. It is such competition that will undoubtedly induce the development of new and more scientific methods of utilization, together with a more rational selling organization. These remarks are peculiarly applicable to Western Canada.

GENERAL REMARKS.

In evaluating a coal area, due regard must be given to the elimination of such portions as are in no way useful. For instance, a property may be altogether economically inaccessible. Again, it may be accessible at one point, but the limit to which haulage can be carried with profit will determine that part of the area which alone is commercially valuable. In a certain case that I have in mind, where the seam is steep-pitching, thick, regular, and enclosed by good walls, mining has been prosecuted for over 2½ miles along the strike, and there is no reason why it could not be pursued for twice this distance. Haulage and timbering expense will probably be the chief items of expense which will decide the limit of exploitation from the present pit-mouth. Ventilation at this mine, I might say, is secured by advancing the fan along with the workings.

When the overburden is of such thickness and of such a nature that great weight must be supported, and when occlusions of gas are apt to be troublesome, owing to sudden outbursts, and where the ventilation is extremely difficult, we then have another phase which may absolutely prevent the carrying on of mining. Or again, the dimensions of pillar support required may be so large in proportion to the coal extracted, that the slow development proves a deterrent. We have illustrations of these.

There has not, as yet, been evolved in our Western interior mining an economical process for replacing the coal pillar supports, such as sand filling, etc. Long wall mining, however, in some of the thinner seams, might well be substituted for pillar and stall.

Deep shafts sunk through rock would handicap an operator with this initial dead expenditure, in competition with other producers who are not under the necessity of such outlay.

Where shafts or slopes, on the other hand, are driven in coal throughout, the sinking is in the nature of development, and the increased cost, due to winding, over and above that of gravity planes in other mines, would not be such as to preclude successful competition.

If the coal concession be a leasehold with a limited life, the acreage which can be mined during that term is all that can be accounted valuable. This must be figured upon the basis of an assumed annual output. Let us make this clear by a hypothetical case:

The amount of leased land	5,000 acres.
Thickness of workable coal	11 feet
Mining losses	25%
Coal content of seam per acre	1,000 tons per foot of thickness
Daily output	500 tons
Working days per year	250
Term of lease	40 years

Then at the termination of the lease there will have been worked out.

$$\frac{500 \text{ x } 250 \text{ x } 40}{11 \text{ x } 0.75 \text{ x } 1000} = 666.6 \text{ acres.}$$

At the end of the term there would therefore be 4333.4 acres of the land which remained unworked, and upon which lease rental has been paid for the full period. For further purposes of illustration, let us assume this to be 4,000 acres. The government rental is $1.00 per acre per annum, or $4,000 yearly, for 40 years. This sum, if otherwise invested at 5% per annum, compounded yearly, would have amounted at the end of the 40 years to $483,100.00.

All useless expenditure may be treated in the same manner, and similarly charged up to capital account.

I have intimated that the actual value of the mine plant is not in excess of its net earning capacity. If too small, it is deficient; if too large, the superfluous equipment from an operating standpoint may fairly be appraised at scrap value only.

Likewise, I might assume that the coal rights should be evaluated only upon the basis of net earnings, after all other estimates, expenditures and the capitalization have been determined.

For the better elucidation of this, I have prepared a statement, which accompanies this paper, and which is but a tabulation of six purely hypothetical cases. In this statement I have shown how to arrive at the evaluation of the coal lands

per acre, after assuming as fixed the various other items, namely: number of working days, output, acreage of holding, cost of mining, selling price, dividend percentage, total receipts, total expenditures, depreciation of plant, and capitalization.

Although the tabulations have been arranged to suit leased, prairie sub-bituminous or lignite coal mines or lands, the principle involved may be applied equally to any property, and this is my basis of evaluation of coal concessions.

I would wish, particularly, to draw attention to the fact that I have fixed the capitalization upon the basis of actual outlay from subscribed capital.

CONCLUSION.

The prime object of all such papers as this I have the honour to present before the International Engineering Congress, is to incite profitable discussion, and thus to stir up interest in the betterment of the industry. I have no doubt that in Western Canada, and in the Northwestern States, coal-mining suffers from identical maladies. We can not and must not blink the fact that disregard of the true principles of evaluation has been a contributory cause in crippling the industry. Whilst we are urging our respective Governments to help us, we must not forget that we have our own clear duties to perform. Not the least of these is preaching the gospel of practical common sense in appraising coal lands.

Paper No. 156

THE COAL MEASURES OF FRANCE, THEIR PRODUCTION AND FUTURE.

By

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France as a country appears poor in coal, if a comparison is made between the limited extent of the coal producing territory and the total area of the country, or equally between the annual production and the total tonnage consumed by the country during the same period.

The position of the principal coal deposits, near the northern frontier or in mountainous parts of the country, aggravates the conditions of transport toward the centers of consumption, and as a result certain provinces and certain industries receive the French coal, loaded down with freight charges, notably greater than for foreign coal.

The French coal mines are located, almost entirely, far from the seacoast. Maritime commerce and the great shipping ports in France are therefore led to procure from foreign sources most of the coal which they require. Likewise, the metallurgical industries in Lorraine, so well advanced as a result of the rich beds of iron ore recently developed along the eastern frontier, are for the most part provided with coke and coal from Germany.

France possesses mineral fuels in all varieties from anthracites with the least proportion of volatile matter, through to the lignites, the most recent in formation and the most heavily charged with moisture and with volatile matter. It may, however, be noted that the most important and most productive deposits furnish especially coals for gas and for coke of high metallurgical value; the quality compensates in some degree for the insufficient quantity.

The law which governs the mining industry in France gives to those who devote their activity to the search or the exploitation of deposits of mineral fuels a perpetual property right in the mine, stipulating that this property right is disposable and transferable the same as all other property, and that the owner cannot be dispossessed except in similar cases and under prescribed forms as for all other property.

It is understood that capital would eagerly seek investment in the development of mining enterprises. Wherever the continuity of the natural mineral wealth has been previously assured with sufficient care, and where the management has been rationally followed up, the capital engaged has, in consequence of the mining legislation, had every guarantee of security and has earned large returns. This explains the eagerness with which search for extensions of the coal beds, both laterally and in depth, has been followed up, as long as the bases of this fostering legislation have not been imprudently disturbed.

The principal coal deposits in France are distributed on the one hand around the central granitic massif, and on the other hand, on the prolongation of the Westphalian and Belgian coal deposits.

The deposits thus far found in other parts of France have, so far, furnished only an inconsiderable supplementary supply, and there seems to be no likelihood of any better future.

The coal deposits grouped around the central massif furnished, almost alone, the supply for France up to the middle of the last century, and it is only in the second half of the 19th century that important geological discoveries in the region of Le Nord and of Le Pas-de-Calais resulted in the recognition of the western prolongation of the coal measure basin, and made possible the realization of these immense installations which have carried the production of this limited region to nearly 30,000,000 tons, while the sum total of all the other exploitations of coal in France does not reach 12,000,000 tons.

The conditions under which the coal properties in Le Nord and in Le Pas-de-Calais were developed, thanks to the experience acquired, have notably contributed to the rapid development of a profitable status for these workings. Renouncing the indefinite parcelling out which has paralysed the development of the other

coal deposits, the French Government gave to each concession granted, at this recent period, an area varying generally from 2000 to 3000 hectares (4900 to 7400 acres), which has permitted the organization of each enterprise on a scale corresponding to the results sought, and the reservation to each group of shafts, of a field of exploitation sufficient to be remunerative, while not too extended with regard to the conditions for good technical management.

The extreme parcelling of coal property, in the other coal bearing areas in France, was for a long time an obstacle to economical development as well as to technical progress, and it was found necessary to combine, among a small number of companies, a great number of small concessions in order to permit these old French enterprises to rival their competitors of Le Pas-de-Calais.

COAL BEARING DEPOSITS SURROUNDING THE CENTRAL MASSIF.

About the boundaries of the central massif of France are disposed, in basins of extremely variable area, coal deposits in great number, but most commonly without real importance from the economic view-point.

The best known is situated to the east of the central massif. It is the basin of Saint Stephen. It extends over a length of about 40 km. (24.8 mi.) and reaches a width of 10 to 12 km. (6.2 to 7.5 mi.) in its central part. Presenting only a narrow point at the crossing of the Rhone, it was for a long time considered as terminating toward Communay. A careful geological study of the boundaries of the plain, which was carried as far as Isère, led Prof. Gruner, in 1870, to indicate the probability of the existence on that side of the Rhone of a new and important coal deposit. Some few borings carried out toward 1880 served to confirm the existence of regular strata pertaining to coal bearing formations, but gave only uncertain results as to the actual existence of coal strata. Undertaken again and interrupted several times, these efforts finally resulted, in 1914, in showing, by borings, the existence of several workable veins of coal, similar to those of the St. Stephen's basin. It may be foreseen, that, at an early date, there will be in profitable operation in the vicinity of Lyons a new group of exploitations, which, it appears,

should notably increase the coal production of this part of France. This is, to all appearance, a discovery of the first order. But for the demoralization of industry resulting from the present war, these developments would have already realized results permitting some estimate of the new wealth to be added to the national credit.

The coal basin of Saint Stephen comprises two series of deposits, which, unfortunately, do not appear to exist simultaneously one over the other, since, thus far, no search, even when pushed to 1150 m. (3772 ft.), has served to demonstrate the level of Rive-de-Gier under that of Saint Stephen, at least in the form of workable veins.

The principal veins of the Rive-de-Gier level are five in number, in the midst of a rock formation of 120 meters (394 ft.) of schist and sandstone. The thickest vein reaches, at places, a thickness of 15 meters (49.2 ft.); the others are of variable thickness, reaching in places as much as 5 m. (16.4 ft.). The nature of the coal also changes rapidly, passing from a content of 30 to 35% of volatile matter to a content of 7 to 10%. With but small extent in area, these veins offer for the future only a narrowly limited ultimate output.

Very different is the outlook with respect to the exploitations extending in the region of Saint Stephen. This level reaches a thickness varying from 1300 to 1500 m. (4264 to 4920 ft.) and contains some thirty veins of various thicknesses, reaching, according to location, from 50 to 80 m. (164 to 262 ft.) of coal.

Several of these veins are of a remarkable purity, and give coal for blacksmith work, and coking coal, of the highest repute.

Cut by numerous faults and accompanied by offsets, often very considerable, this coal-bearing basin, in spite of the very methodical studies to which it has been subjected, has not as yet been completely located, and new marginal extensions may still further increase the reserves for the future. Below 900 m. (2952 ft.) the deposit is still less known.

The annual production of this basin varies between 3,600,000 and 3,800,000 tons. The present developments indicate, as certain, about 140,000,000 tons and as probable, from 250,000,000 to 300,000,000 tons. It appears, therefore, that at the present

rate of output, the production of this coal field has before it a future not much exceeding a century. It is true that probabilities of the extension of the veins may permit the consideration of a possible life double the above period, with a rate of production sensibly the same. The economic future of this rich industrial region is then seriously interested in the reconnaissance work on the left bank of the Rhone.

Situated on the southeast of the central massif, the coal basin of the Gard is cut by faults so numerous and has been subject to offsets so extended that the valuation of the deposits is still the subject of serious controversy. The coal exploitations have been opened up from various valleys which penetrate into the ridge of the Rouvergue, as well as into the plain which opens to the south. The relations between the veins thus opened up in the three principal groups of concessions, Grand Combe, Bessèges and Rochebelle, are still the subject of divergent hypotheses, which lead to more or less discordant valuations with regard to the future production.

The total area of the coal-bearing basin of the Gard does not exceed 12,000 ha. (46.3 sq. mi.). The total depth of the coal-bearing measures appears to reach 2500 m. (8200 ft.), but at no point do the present workings reach below 800 m. (2624 ft.).

According to the regions, separated by faults with great offset, there are found various groups of veins, from fine coking coals to anthracites poor in volatile matter. At Bessèges and Lalle there are known more than 20 veins with 25 m. (84 ft.) of coal. At Rochebelle, the 25 known veins comprise more than 40 m. (131.2 ft.) of coal, and in the concession of Grand Combe, according to location, there are in working from 6 to 12 veins of coal.

Near the volcanic central massif of France, the basin of the Gard presents certain peculiarities which notably aggravate the conditions of exploitation. Certain strata of the coal-bearing territory are strongly impregnated with carbonic acid or with coal damp, and give rise to the instantaneous disengagement of one gas or the other, resulting in the projection of hundreds of tons of finely pulverized coal, with invasion of all the workings, and sometimes even of the surface in the vicinity of the shaft openings, by one or the other of these gases. This special hazard

necessitates, for the exploitation, a very strict code of regulations and prescriptions, unknown in other districts. The breaking up of the veins by faulting, complicated by these special dangers, limits the production of this basin, which furnishes only about 2,000,000 tons per year.

The veins definitely located do not reach 100,000,000 tons probable output. It does not, however, seem excessive to consider an output three or four times this amount. It would appear then that the exploitation of this basin may, at the present rate of output, continue for 200 to 250 years, and perhaps for double this period, if certain geological hypotheses are confirmed and if the special difficulties resulting from the instantaneous liberation of gas do not become aggravated to a degree which might seriously limit the annual output.

Ascending the course of the Rhone and of the Saone toward the north, at the foot of the granitic massif of the Morvan is found an elongated basin, directed southwest-northeast, and of which the extreme limits are still only vaguely known, but which, over a limited part of its extent, contains strong veins of dry long flaming coal. This is the coal basin of Blanzy. From the viewpoint of production—about 2,000,000 tons per year—this basin is about the equivalent of that of the Gard, but the quality of the coal produced is far from equalling that of the other basin.

The recent discovery of the extension in depth, beyond the great longitudinal fault, of the veins now developed near the surface has given to the future of this basin unhoped for probabilities. While before this discovery it was foreseen that within a period of 30 years a condition, if not of exhaustion, at least of serious reduction in output, would be reached, now it seems possible to count on the continuous production of 2,000,000 tons for nearly a century.

If, in depth the deposits in this coal basin are now well located, the lateral extensions, especially toward the northeast, are still the subject of hypotheses which numerous researches have as yet neither confirmed nor disproved in a definite manner.

The question is still asked if there may not exist other lateral coal-bearing extensions of some importance between this basin of Blanzy and that of the Vosges (Ronchamp) and still farther eastward to the great coal basin of Saarbruck. This is,

without doubt, the prolongation of the basin which has been located between Dombale and Pont-à-Mousson in the department of Meurthe-et-Moselle, by a series of borings which have not yet been followed up and extended by shafts and galleries.

What has retarded these works of reconnaissance is, before everything else, the regrettable hesitation of the Government to maintain intact the law of 1810, which has been the basic code for the mineral wealth of France. What will also, doubtless, cause a new delay in the opening up of these mines, in the economic conditions which will follow the war, is the great depth (900 to 1300 m.—2950 to 4260 ft.) to which it will be necessary to go in order to open up the first workings. The fine quality of the fragments of "fat" coal brought up in the course of the borings will determine, in spite of all, however, the exploitation of these deposits, which the vicinity of the Lorraine beds of iron ore will render especially significant. But to realize this end, the concessions to be formed should not be loaded with charges heavier than the old ones.

The northern zone of the central massif comprises a series of small coal basins, isolated one from another, but of which, unfortunately, none possesses continuity, either in depth or surface extent.

The most important of these deposits, that of Commentry, has been the site, during some fifty years, of a production which appeared considerable for that epoch. But the exhaustion of this basin forces, at this present moment, the complete stoppage of all production at Commentry.

Several other small neighboring basins, Bézenet-Doyet, Ferrières, Ahun, St. Eloy-la Bouble, will continue to produce for a considerable period of time.

The aggregate of all these exploitations scattered throughout Auvergne and le Bourbonnais, do not give, even all together, 1,500,000 tons of coal, and this production is likely to decrease rather than to increase during the century.

To the southwest of the central massif, the coal deposits of the basins of Decazeville-Aubin and of Carmaux are furnishing, at the present time, an output exceeding 2,000,000 tons, and furnish grounds for expecting a duration of exploitation,

perhaps exceeding a century. The fine cooking coals of Carnaux (Tarn), the thick veins of fat long-flaming coal of Decazeville (Aveyron) and the half-fat flaming coals of Aubin have permitted the creation and the development, in this region, of important metallurgical industries, and provide also coal for a number of gas works. Near Decazeville there is now in exploitation, under the open sky, after an extensive stripping, a mass of coal of about 50 meters (164 ft.) thickness—the great strata of Bourran.

Certain estimates carry beyond 400,000,000 tons the workable reserve in this coal-bearing district of St. Aubin-Decazeville, while the total wealth of the Carmaux-Albi basin does not appear to permit of evaluation at more than 70,000,000 tons.

The numerous coal-bearing marginal extensions located and exploited in the west of France, in the midst of the ancient lands of Brittany (Vendée, Maine-et-Loire and Mayenne), have never given and do not appear to be likely to give more than the barest minimum of output of coal, generally anthracite in character.

It is the same with the little coal-bearing basin of the Manche, which is no longer worked, after a short period of prosperity in the 18th century.

In the aggregate, these numerous coal-bearing basins produce about 12 million tons of coal and do not seem likely to show a greater output in the future.

Toward the north of France, on the prolongation of the Belgian coal-bearing basin, is found the real coal wealth of France, the basin of the Le Nord and of Le Pas-de-Calais, of which the output now reaches 28,000,000 tons and certainly has not yet reached its maximum, which may be placed toward 35,000,000 tons, and perhaps even more.

Located over about 100 kilometers in length (62.1 mi.), the coal-bearing basin has an extremely variable width, according to the region, and is generally not as yet well delimited. This lack of determinate location results from the existence of thick strata of ancient soil deposits, which cover, to a variable width, the western border of the coal deposit. It results that the

workings, pushed toward the south, have been gradually extended under an overburden of ancient formations. Numerous borings through these formations, executed some 15 to 20 years since to the south of what had been previously considered as the limit of the coal-bearing basin, after being followed up in the Devonian strata, have penetrated into the coal measures, only to find later, at greater depth, the same Devonian formations. Under this immense overburden, driven over the coal-bearing strata by a violent thrust directed from southwest to northeast, exploitations are already in progress, and more especially in preparation, which will contribute largely to the output of the basin.

The coal veins in the basin of the Le Nord and of Le Pas-de-Calais are numerous, but generally thin (less than 2 meters —6.6 ft.). They furnish all varieties of product, from anthracite to dry long-flaming coals. At no point in French territory do the coal strata come to the surface. Everywhere they are covered with more recent formations, especially the cretaceous.

It is to this absence of surface indications that the tardy discovery of the extension of the Belgian basin was due, a discovery which was much retarded through ignorance of the crescent form, with concavity toward the north, taken by the coal-bearing basin beyond Valenciennes.

The existence of numerous faults, some longitudinal, the others transverse to the basin, renders the connection between the strata, from one part of the basin to the other, very uncertain. The variations, progressive and sometimes rapid, in the composition of a given vein, from one point to another of its development, complicate extremely the task of identification. The veins are often folded in acute chevrons, sometimes reversed.

In the parts the most definitely located, as in the concession of Anzin, the aggregate of the coal-bearing territory exceeds 2000 meters (6560 ft.), and the number of veins approaches 70, forming a total of 45 to 50 m. (148 to 164 ft.) of coal.

In the greater part of the coal-bearing basin, the existence of the lower veins has not been recognized, and numerous researches remain to be carried out in the future, researches

which alone will permit an estimate with some degree of accuracy of the mineral wealth in reserve in this part of France.

In his report to the International Congress of Geology at Toronto, M. Defline, Engineer of Mines, while calling attention to the uncertainty of the basis of estimate which he had been obliged to employ, believes, nevertheless, that he is justified in giving the following figures:

Reserves of Coal at Depths Less Than 1200 m. (3940 ft.)

Assured	3,790 million tons
Probable	3,010 " "
Possible	2,710 " "

Reserves of Coal at Depths Between 1200 and 1800 m. (3940 and 5900 ft.)

Possible	2,580 million tons

Thus, this coal-bearing basin might, in the opinion of this engineer, furnish for national consumption 12,100 million tons, which, at the rate of an annual consumption of 40 million tons per year, would correspond to a duration of three centuries. On the other hand, the aggregate of all the other coal-bearing basins does not appear, to this engineer, to indicate a total reserve superior to 4,000 million tons.

ANTHRACITES AND LIGNITES.

The reserves of anthracite and of lignite which the coal fields of France appear to contain are of very slight importance.

Aside from a few anthracite veins which are found in the Gard, it is in the vicinity of the Alps, in regions not readily accessible, that small and irregular pockets of coal are found, anthracite in general character. There is little beyond the deposit of La Mure (near Grenoble), which reaches an output of importance—about 300,000 per year. The estimate of ultimate output, assured and probable, does not exceed, for the aggregate of the anthracite mines of the Alps, some 5,000,000 tons, and the figure of 100,000,000 tons suggested as a possible output appears to be extremely hypothetical.

LIGNITES.

Although quite numerous in the southeast of France, the beds of lignite do not seem, anywhere, to possess special importance, except in the vicinity of Marseilles (basin of Fuveau). The annual production of this fine black lignite approaches 700,000 tons, and the measurements thus far made justify an estimate of about 300,000,000 tons of assured output, while M. Defline has felt that, without fear of being charged with exaggeration, he could reasonably estimate the probable and possible total output above a depth of 1200 m. (3940 ft.) at 1,000,000,000 tons. It would therefore appear that there is still an important margin for the further development of these exploitations, if the competition, at Marseilles, of coal imported from over the seas does not too seriously restrain the sale of these lignites, which maritime commerce seems to neglect because of too low heat value and of crumbling too readily into fine powder.

In résumé, as to the evaluation of the coal reserves of France, we do not see any important changes to be made in the estimates of total output by M. Defline, in the report which he presented in 1913 at the 12th International Congress of Geology at Toronto, and which, for the anthracite and lignite coals, are as follows, in thousands of tons:

	Assured	Probable	Possible
Reserves to depth of 1200 m. (3940 ft.)	4,500,000	4,300,000	5,800,000
Reserves between depths of 1200 to 1800 m. (3940 to 5900 ft.)	4,500,000	4,300,000	3,000,000

Paper No. 157

WORKMEN'S COMPENSATION AND MINE SAFETY.

By

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Insurance has, in other industrial activities than mining, been one of the most potent influences for increasing the knowledge of the engineering principles on which fire prevention and protection are founded. Much of the value of this educative force has been lost so far as it may affect safety in mining, because insurance has been chary of assuming the risks and has imposed flat rates so high that it has seemed less irksome to the mine operator to contest damage or liability suits than to adopt preventive measures.

Only recently, and as a result of the enactment by numerous States of workmen's compensation legislation, coupled with the better knowledge of the causes of casualties in mines and the means of preventing the same, developed through the medium of the Federal Bureau of Mines, has it been possible to consider schedule rating as distinguished from flat premium rates as applicable to mining.

The most important progress in the direction of encouraging safety against fire or accident in surface structures comes from the pioneer work of Edward Atkinson in connection with factory insurance in New England, and has developed through the medium of that body of engineering specialists known as the National Fire Protection Association and the technical force of the Underwriters' Laboratories in Chicago. The result of the work of these men has made available a mass of scientific data bearing on fire preventive and fire protection measures which has enabled underwriters to offer premium rate reductions in proportion to the safety of a structure or group of structures from fire or conflagration.

Following this lead, the casualty insurance companies organized a few years ago the Workmen's Compensation Service Bureau, paralleling to some extent in accident risks the field covered by the Underwriters' Association and Laboratories for fire risks. All credit is due the pioneer engineering work done by that Bureau in the casualty field in the development of a system of standard safety practices and of schedule rating in connection therewith. And finally, in the life insurance field recently some companies, realizing the advantage to themselves of increasing the safety from disease and death and the importance of prolonging the life of their insured, have organized in certain cities medical and nursing corps, the duty of which is to look after the living conditions and the health and well-being of their policy-holders.

All of these activities have been of great influence in acquainting those concerned regarding their risks and toward increasing their safety from the hazards of fire, accident and disease, and it is not improbable that a large measure of the interest taken in the so-called "Safety First" propaganda has been due to the seed sown through insurance activities.

While the mining industry has been the first to give state, governmental and corporate consideration to the safety of its employees because of the imminence of the hazards, as evidenced in legislation creating bureaus and departments of mines, with mine inspection service, yet mining has been the last of the industries to benefit by that added impetus given by sympathetic insurance protection. This because it has been the belief of insurance companies that the risks in mining were so great and their causes so little known that they could not safely underwrite them, wherefore, the rates offered have been such as to discourage their acceptance.

Under workmen's compensation acts mine operators can no longer risk possible insolvency as a result of compulsory payment of large indemnities to the great number of men who may be injured in a mining catastrophe, nor can they risk the even greater sums which must be paid for all injuries from other causes.

Ten of the great stock casualty insurance companies realizing the necessity of accepting any risk in any compensation

state, the most hazardous along with the best, have recently undertaken to extend protection to the coal mining industry and have organized to that end a bureau, corresponding in some measure to those of the Fire Underwriters' and the Workmen's Compensation Service Bureau, known as The Associated Companies, the purpose of which is to give reductions in premium rates based on technical inspection as to safety, which reductions shall recognize every safe measure adopted.

The entrance of this powerful group of insurance companies into the mining field,—equipped with a large force of skilled inspectors and backed by adequate capital—promises to be one of the most potent influences for increasing safety in mining, and in accordance with scientific and engineering methods, since the creation of the Federal Bureau of Mines.

The activities of the Bureau of Mines in classifying and gathering statistics relative to the causes of accidents, in determining the nature of these causes, and in devising means for the prevention thereof, have been a necessary preliminary to the step now taken for mine insurance; since without the statistical and technical data so gathered, and the scientific principles thus evolved, it would be impracticable for insurance to offer graduated premium rates for relative safety.

I have recently made an analysis of the various accident causes with a view to fixing a numerical value on each and applying to each safety measure a corresponding credit and to each hazard a debit value. In this work I have been materially aided by the engineers of the Bureau of Mines as well as by several state mine inspectors, mine operators and higher officials of the mine workers' organizations, with the result that I have developed a system of inspection and rating of mines as to safety which is based on the percentage causes of accidents furnished by the statistics of each state and checked by the average for the whole United States.

Thus, for example, falls of roof and coal cause 43 per cent of the injuries, haulage accidents account for 21 per cent, and so on. Each of these primary causes is made up of separate hazards and to each of these latter is given a percentage value. Thus, the frequency of accidents from falls of roof and coal is dependent on the character of the roof and rib, the amount

and kind of timbering, supply of timber furnished at the working places, inspection and testing of roof, and a dozen other elements; similarly for haulage, shaft, electrical and other accidents.

The inspection of a mine by the engineer of an insurance company, with the fixing of numerical values for relative safety of each of the elements which may produce accidents, has a marked influence in drawing the attention of mine officials to the hazards of their operations, the existence of which has not occurred to them. Even state inspection, with its police powers, is not so influential in pressing home the nature of the risk and the value of preventive measures as is an increased insurance rate or a reduction in insurance premium under workmen's compensation legislation.

The problem of safety in mining thus becomes at once a matter of earning power for the mine instead of being merely a psychological propaganda. Instead of the mine operator spending large sums in the employment of lawyers in combating litigation, these sums may be devoted to improving the safety of his mine, thereby earning a reduction in the insurance premium which under compensation legislation he feels compelled to pay. The effect on efficient and economic operation is further felt in the improvement of appliances whereby the accident causes are reduced. Thus, haulage accidents are largely the result of bad roadbed, light rails, bad tracklaying and maintenance, faulty illumination in the haulageway, a bad haulage system, light and not tight cars, and similar elements. Improvement in the character of the roadbed and track, and of the cars and the haulage system, will add greatly to the safety from haulage accidents, and will greatly increase the efficiency of operation by permitting the hauling of larger loads and at higher speeds for each trip. Similarly the adoption of undercutting as a means of preventing blownout shots and the injuries resulting therefrom, leads under many conditions to an improvement in the size of the coal and in the efficiency of production, as will many other safety measures. And, finally, the unknown financial obligation which must be met by placing a higher price per ton on the coal under uninsured liability legislation is replaced by a known and fixed

obligation under compensation acts protected by stock company insurance, whereby the mine owner may figure to a nicety his liabilities on accident account.

Similarly in the fire protection field, improvement in insurance rates resulting from the introduction of fireproof materials about the headhouse or tipple, in the shaft and in the main entries, while they have increased the safety from fires, have also reduced the charges against mine operation by increasing the permanency of the timbering and the efficiency of operation.

All of these improvements in mining, in efficiency and safety, have been the result of the employment of a higher grade of officials, largely those trained in mining engineering, and of a better trained corps of inspectors, and, also of the technical experts in the service of the Bureau of Mines. The mining industry may now well look upon agencies which have heretofore seemed inimical to its welfare as fraught, on the contrary, with promise of a better future for the industry.

Considering now in detail the various causes of accidents to miners and the means which may be adopted for their prevention or amelioration: an inspection of the statistics of coal mine, metal mine and quarry accidents as compiled by the Bureau of Mines from state inspectors' reports, and reduced to a comparable basis as to cause, shows that these may be divided into three main groups, viz., underground, shaft and surface accidents. These three groups may be again divided into ten or more separate causes, the methods for prevention of which are coming to be fairly well known.

Looking now upon these causes from the viewpoint of safety measures for their prevention, and adding to these physical safeguards those psychological ones which are comprehended in the Safety First propaganda, we find in substance as follows:

That the attitude of the mine management and officials, and the number and character of underground bosses and inspectors, is a large element in producing a safety sentiment and the essential discipline whereby the safety measures adopted will be more surely enforced; that such safeguards as company surgeon and hospital, first aid and mine rescue sup-

plies, crews and training, illumination, telephones, signals and bulletins, all perform an important part in preventing accidents, or in more rapidly restoring the injured miner to normal condition.

We find, further, that the number of injuries from falls of coal, ore, roof or rock may be greatly diminished by better, more systematic and adequate timbering and supply of timbers at the working place and in the entries or drifts; by better inspection of the roof and rib at the working place; by exercise of discrimination in the amount of timbering, and by a better technical knowledge of the forces tending to crush coal or ore left as roof support and the amount of such support necessary to prevent caving, slips or other causes of fall of roof, ore or coal.

It has already been indicated that the number of injuries from haulage, which in the aggregate is second only to those injuries from falls of roof, rock, coal or ore, may be greatly diminished by improvement of the roadbed and track, separation of manway from haulageway, better illumination, adequate clearance and cleanliness in the haulageway, better type of motors, tight cars, not topping latter, greater care in placing the trolley in relation to the track, and many other kindred items most of which are well known to the thoughtful mine operator but many of which have been disregarded on the false assumption that their remedy would add to the expense of operation or diminish the rate of production.

The large number of accidents due to electricity has been reduced in many mines and can readily be reduced in others by a better knowledge of electricity, rarely had by the average mine employee. These hazards are due in large measure to too high voltage, any in excess of 300 volts being now deemed unsafe. A better protection of trolley wire at crossings and other dangerous places, better grounding of the system and, generally, a better and more permanent electrical installation, including guards and insulation of cable connected with mining machines and electric drills, will go far toward eliminating this class of accidents.

The causes of shaft and slope accidents are well known and easily preventable. The employment of the best type of

hoisting engines, the adoption of a safe number of laps of cable on the drum, guards and guides for cage, bonnet or other protection from falling objects, safety catches, better inspection of condition of cable, total prohibition of men riding on same trips with materials, protection against overwind and an adequate signalling system and indicator or other means of ascertaining at all times the position of the cage, are practically certain remedies for the majority of shaft accidents.

Surface accidents, which make up a small percentage of the total of those occurring in and about mines, are more nearly related to those occurring about surface industrial establishments. The larger items in these are shown by statistics to be due to outside mine haulage system, to railway locomotives and cars, obstructions along side track, bad illumination in buildings, inadequate boiler inspection and machine protection, condition of floors and stairways.

The use of improper explosives and the improper use of explosives cause a large percentage of the accidents in mines, and aside from the effect of these in initiating gas or dust explosions or mine fires they are a fruitful source of injury to one or more nearby mine workers. The causes and, conversely, the remedies are care in storage and handling the explosives, in carrying same from the outside to the working places separately from the detonators or fuse, and a limited, or one-day, supply for each man, in safe and tight receptacles; care in placing the shots; avoidance of mixed charges; limiting the amount of charge; shooting by skilled miners or shot-firers; the use of electric detonators; care in returning to the place of shooting after ignition to avoid asphyxiation or delayed shots; and, in case of misfires, care in examination or removal.

There is a group of accident causes differing from those enumerated, in that the foregoing involve usually the safety of only one or of a very few employees, whereas this other group may involve the safety of several or even all of the men working underground. These include, in the inverse order of their seriousness, mine fires, gas explosions and coal dust explosions.

Mine fires may follow an explosion in a coal mine if the ventilation is restored before the fires are extinguished by men

protected by breathing apparatus; they may be caused by spontaneous combustion in coal, gob, sulphites or oily waste; by electricity, explosives, open lights and the presence of inflammable materials. Protection against them should be available, especially in the form of adequate water supply, piping system and hose, fire extinguishers, fire rules and signals and trained fire fighters with breathing apparatus.

The accumulation of gas in a mine is largely due to faulty ventilation, in either metal or coal mine, though the hazard from this cause is vastly greater in coal than in metal mines. The explosive gas, being lighter than air, accumulates near the roof or in the highest place in the mine, wherefore a gas ignition or explosion is not propagated beyond the immediate supply of explosive mixture and, hence, usually involves only one or a few men. In a large number of instances the accidents from gas are due to burns, the gas not having a sufficient admixture of oxygen from the air to cause an explosive mixture.

The obvious remedy for this class of accidents is adequate ventilation, taken right up to the working place. Be the mine ever so gaseous, were the air current taken, as it should be, beyond the last crosscut and to the very working place in quantities prescribed by the mining laws of most states; were the fan of improved type, protected by explosion doors, safely situated with relation to the main shaft, and with a duplicate as a protection against interruption to fan action; and were a proper system of gas inspection and report through the medium of skilled firebosses insisted upon, including the use of safety lamps and, in gaseous mines, the prohibition of open lights, the risk from gas burns or explosions would be reduced to a negligible quantity.

It is now well known that those great mine explosions which involve the entire mine and every man working therein are caused, not by gas but by coal dust or by mixture of the two. In the majority of cases, dust explosions are initiated either from a blown-out shot or other discharge of explosive in the presence of an appropriate mixture of inflammable coal dust and air, or from a gas explosion, or from an ignition converted into a dust explosion through the presence of small percentages of gas mixed with dust. A dust explosion being once

started, it blows ahead of it into the atmosphere and thus mixes properly with the oxygen thereof small quantities of finely comminuted dust which may be on the roof, timbers or floor, thus furnishing the explosion food upon which to feed and propagate, thereby ultimately involving the entire underground workings.

The methods of preventing such explosions are now coming to be as well known as are the causes. The mine should be kept clean of coal dust as far as possible. The sources of ignition of dust near the working place should be reduced to a minimum, such as the possibility of blown-out shots, either through overcharge or failure to undercut or shear the coal. Permissible explosive should be used and sufficiently strong detonators to insure complete explosion. Coal dust in working places, haulageways and on cars should be thoroughly wetted or should be made immune by admixture of a sufficient amount of stone dust to render it non-inflammable. Causes of production of dust in the working place should be reduced to a minimum, as should those in the road, such as overtopping of cars, leaky car bodies and bad track.

An explosion of coal dust having been started, its propagation throughout the mine may be limited by the use of stone dust and other explosion-proof barriers or by thorough saturation of the entries with water, as well as by the absence of inflammable dust on which the explosion may feed.

Another potent means of preventing injury to persons by dust explosions consists in blasting when all men are out of the mine, preferably by electricity fired from the outside, or by skilled shot-firers when all other men are out; though the shot-firer system has its disadvantages in causing the loss of life of too many of the men so employed because of the employment of too few and consequent hurry in their work.

Ultimately, and whatever other means may be adopted for reducing the number of injuries to mine workers, the strongest influence for good in this regard will be through education of the owners and managers of mines concerning the value to their property of the safeguarding of the lives of their workers, when the same is subject to the positive liability for injury involved under workmen's compensation acts; the consequent

necessity which the operator is under to secure insurance protection; and, finally, the tremendous influence for safety under such system which will come from the provision of skilled insurance inspection whereby reductions are given in premium rates for safe practices, based on the relative hazard of such practices and the means of preventing injuries, as developed through the investigations of the Bureau of Mines.

Paper No. 158

THE FUNCTIONS AND WORK OF EXPLORATION AND DEVELOPMENT COMPANIES.

By

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The proper author of an article on exploration companies should be the consulting engineer of such a company, with experience extending over the whole world and over a long space of time. I presume that the difficulty of securing an authoritative paper from such a source arose in part from business reasons and from the diffidence of such engineers in confessing all their worries resulting from the examination every year of numerous prospects and mines, with mostly negative results—due in most cases to lack of evidence of substantial ore bodies; in other cases to the difficulty of buying at a reasonable price and on reasonable terms; or because of adverse laws or high government taxes.

Having had but a limited experience with exploration companies, I have thought best to present, rather than my own views exclusively, abstracts of the views of such other engineers as have expressed themselves in print. For after all, this is a wide subject and the experience of any one company or any one engineer is hardly adequate to represent the function and work of exploration and development companies in all their numerous phases. I have, therefore, drawn freely on all writings that I have come across that seemed to have any pertinent bearing on the subject in hand, including data about prospecting, mining geologists, mining laws, and mineral production. The Mining Magazine of London and Mining Press of San Francisco, especially, have furnished much information. It should be emphasized that this paper is not written for the instruction of ex-

ploration and development companies, who know quite well what they want to do and where they want to go for investments, but for the general public who are interested in mining matters.

HISTORY OF DEVELOPMENT COMPANIES.

When was the first exploration or development company formed? Probably at a remote era in the past, as soon as primeval man began the exploitation of the natural resources of the world. We have, however, in Agricola, as translated by Hoover, evidence that the whole subject of mineral exploitation was well understood, in its essentials, in the early part of the sixteenth century. Agricola advises that when ignorant of the art of mining an investor should share in common with others the expenses of development not of one mine only but of several mines, for if out of twelve in which he has a joint interest, one yields an abundance of metals, the speculation will be profitable; and that in buying shares, the investor should go to the mine and carefully examine the nature of the vein, for it is important that he should be on his guard lest fraudulent sellers of shares should deceive him.

Here we have surely what are, practically, development companies, taking up several prospects with the expectation that one or more will be profitable; we have also the advice to examine the mine before buying shares, only nowadays the capitalist sends an engineer for this purpose; and we have the unscrupulous promoter who sells shares in worthless mines. If in the recent Tonopah-Goldfield mining boom, investors had heeded these admonitions, written nearly 400 years ago, there would have been fewer investors, to be sure, but less money lost by the buyers of cheap shares. But so strong is the gambling propensity that no doubt the same thing will be repeated in the future, as it has been so many times in the past.

WHAT IS THE PROPER FUNCTION AND WORK OF EXPLORATION AND DEVELOPMENT COMPANIES?

Plainly to explore lands, concessions and mining districts for promising mineral deposits and other resources; to develop such as seem worthy; and then to sell or operate the same.

As every one knows, development companies, properly so-called, do confine themselves chiefly to such work, and having

developed a deposit sufficiently to prove that it will be profitable under the conditions, form a subsidiary company to operate the same, in which case the shares of the subsidiary company are usually offered first to the shareholders of the parent company; or the deposit is sold to other interests.

But if we inquire into the operations of many of the large combinations that are designated exploration companies, we will find that most of them will take hold only of prospects that are fairly well developed. We may also note that many mining companies, while operating a given mine, spend yearly a certain amount on testing prospects in their neighborhood. To the extent of such exploratory work, such companies are true development companies. Then again, as the ore begins to give out in a given mine, the company may search the world over for another property with which to continue their corporate existence. In this matter, for example, the stronger companies of Tonopah and Goldfield, Nevada, have been active in late years. Thus the Montana-Tonopah has taken over the Commonwealth mine at Pearce, Arizona; the Goldfield Consolidated, the Aurora mines; and the Belmont is said to be developing the Surf Inlet Gold mine of British Columbia and to be prospecting for gold in Nicaragua.

What may be designated as a true development company is the Grubstake & Mining Company of Colorado.* In 1911, the citizens of Colorado, through the Denver Chamber of Commerce, resorted to an unusual but apparently sensible expedient to rehabilitate the State's metal-mining industries. A Grubstake Committee was formed, empowered to make contracts with prospectors and furnish the necessary supplies for the season. These contracts provided that all locations should be made jointly in the name of the Chamber of Commerce and the individual prospector, both being equal owners. For this purpose, $9,215 was raised, and 34 prospecting parties sent out. Forty-three claims were located, and on each the usual discovery shafts were put down. In 11 of these good ore was discovered in 10-foot holes. These results were considered satisfactory and in consequence the Colorado Grubstake & Mining Company was formed. Several good engineers were associated with this company, but the

*Walter A. Koch, Min. & Sci. Press, Dec. 23, 1911.

final results of the enterprise are not at hand. It is reported that no deposit has been brought into production.

In London, it is the rule, rather than the exception, for exploration and development companies, and mining companies generally, to add to their stability by owning shares in mines other than those they operate. The consequence is that the interests of many of these companies are so interwoven that one can never tell from the name of the corporation what mines are in their control, as may be noted from the following particulars:

Rand Mines, Ltd.—Interested in 18 gold mines on the Rand, in a cement company, in gold mines in West Africa, in tin mines in Nigeria, in several Estates companies and in government bonds. This company has paid $50,000,000 in dividends.

Anglo-French Exploration Co.—Interested in the Rand gold mines, in Transvaal coal, in Rooiberg tin, and in business in Australia and Canada.

Exploring Land and Minerals.—Interested in lands in South Africa with cattle, mining lands in Mashonaland and Matabeleland, and tin in Nigeria.

Oceana-Consolidated Co.—Interested in a coal mine in southern Rhodesia, in gold mines in West Africa, and in the Piccadilly Hotel in London.

Henderson's Transvaal Estates.—Interested chiefly in South Africa; in gold mines, in coal, in cement, and in irrigated lands.

In our own country, the Guggenheim Exploration Co. owns shares in the Utah Copper, Chino Copper, Ray Consolidated, American Smelting & Refining Co., Smelters Securities Co., and the Yukon Gold. The United States Smelting, Refining and Mining Co. owns not only important copper mines, but also gold mines; it is interested either directly or through subsidiaries in smelters, mines and mills at Pachuca, Mexico; in the Peruvian Mining & Smelting Co.; in the United States Lime Co., etc. This company has a fair claim to be called a development company, as there are probably few new prospects of promise within North America which it has not at least examined.

When development and mining companies are looking for new properties they have the choice of taking up prospects but little developed, when new developed ore bodies are not avail-

able, or of re-opening old mines. Frequently the latter are caved in or filled with water, and American companies appear to be generally adverse to such operations, chiefly because they must go to considerable expense before they can get first-hand information as to the nature and value of the deposit; however, the same is true with prospects, except those fairly well developed, and with old mines, the record of past production gives some guarantee as to what a given mine may do when re-opened, provided the evidence for persistence of the deposit in depth is good.

Many good mines are closed down, not from lack of ore, but from metallurgical difficulties with ore in depth, or because of having reached a lean streak in the deposit, and for many other reasons not connected with the exhaustion of ore. All engineers familiar with Mexico can enumerate mines of this character now successfully operating and the same is true of many old mining districts. In Burma, the Bawdwin is a conspicuous example of the successful re-opening of an ancient silver-lead mine, the new company at this date having developed over 1,000,000 tons of complex sulphide ore, containing chiefly lead, zinc, and silver. The Mysore, a gold mine of the Kolar field in India, is another example of an abandoned mine profitably reopened, the production for the year 1914 being about $4,000,000, with ore reserves in excess of 1,000,000 tons.

In Russia, where large concessions are obtainable, English mining companies have had great success in developing substantial ore bodies in several old mining districts.

Coming closer home, we have in the Gold Belt of California other examples. Many mines were closed down at comparatively shallow depths, because of lean levels, etc. The re-opening of such of these as had profitable ore bodies in the upper levels has been quite generally remunerative, when there was reason to expect persistence in depth. This has been done by a comparatively small number of men who had the courage of their convictions, and as a result we have the Kennedy, Plymouth and Gwin on the Mother Lode and the North Star and Empire in the Grass Valley region. And there are others, but success does not always attend these ventures; yet the above examples suggest that a development company can gamble as legitimately on

old mines as on new prospects. More such mines in the California field would probably be examined were it not for the expense of unwatering; and yet this is not great compared with the possible profits to be won. Thus the Plymouth Consolidated Gold Mines removed over 43,000,000 gal. of water from the old Pacific shaft at an expense of only $15,000, not including the equipment, which remained as an asset after the unwatering was completed. This work was done in seven months by bailing with 500-gal. skips, electrically operated.

MINING INVESTMENTS FOLLOW THE FLAG.

The strength of London as a mining center lies not only in its great commerce and resulting wealth, but also in its colonies. As this commerce is not likely to decline in the near future and as the colonies will remain loyal, we may expect London to retain the supremacy until such time as the center of commerce and money may shift elsewhere.

The commerce of England is predominant with China, India, Australasia, South Africa, South America, and Canada. If now we look into the mining development in these various countries, we will find that the foreign operating companies are chiefly English; although in Canada and western South America the investments of United States money are large, but this is due in the case of western South America, where all the important United States investments are comparatively new, to the Panama Canal; and in the case of Canada, to proximity and extensive overland commerce.

English capital is likewise predominant in the Russian Empire, and this is likely to continue to be the case until the Russians themselves take a greater interest in mining investments and the Russian engineers become generally familiar with modern mining and metallurgical methods. It is true that Germany being a great manufacturing and commercial nation and a neighbor of Russia, the overland commerce between the two countries has been predominant; but in mining investments, the Germans appear to hesitate to provide the necessary funds for large ventures in Russia, while the English people are quite willing to do so, when it is shown that the enterprise will be remunerative.

Travel, like all other things, tends to follow the lines of least resistance; hence the Englishman is ubiquitous in the countries above named. In all new countries there are possibilities of new enterprises and the promoters naturally send news of their discoveries or schemes whither commerce trends and where they have friends; in this case almost surely to England. Thus the trade routes usually decide to what market a deposit will find its way. In other words, foreign mining investments, like commerce, follow the flag.

New York as a Money and Commercial Center.

Do American foreign investments follow the flag? I reply, yes, when we have a flag. As we all know, it is a rare sight to see the Stars and Stripes at the mast-head away from our own shores. An American mercantile marine service can scarcely be said to exist and can only regain and surpass its former importance when laws favorable to the shipping interests are passed. Unquestionably, the natural field for United States foreign investments is the American continent. New York is our money and commercial center, and may possibly within a generation become the money and commercial center of the world. It is more likely to do so if the Pan-American efforts to establish United States banking facilities in the South American republics and to connect these countries with ourselves by steamship lines flying our own flag meet with success. We may note in this connection that the National City Bank of New York has recently established a branch in Montevideo, Uruguay; that J. P. Morgan & Co. has loaned Chile $6,000,000, and that an important loan has been made to Argentina by New York financiers.

But good shipping laws are imperative, if American commerce and mining enterprise are to dominate the American continent. In this matter, we have within ourselves our main foe, that is, our general aversion to create subsidies or other form of assistance to our maritime shipping interests. We are strong in protecting our domestic infant industries, like the Steel Trust, but the development of a mercantile marine, a much more important matter, does not appeal to our sympathies. It may be remembered that when the Ship-Subsidy bill was before Congress, a few years ago, it was defeated by the vote of members from the

Mississippi Valley States. The good people there, with their unlimited acres of waving grain, with their corn, coal, petroleum, iron-ore and steel plants, apparently did not see much value in shipping outside of that on the Great Lakes and the Mississippi. Truly, what more could one want, anyway. Few people of the United States realize their wonderful inheritance. There is probably no other area of equal size in the world of the same varied natural resources, and to this, as much as to our own energy, do we owe our phenomenal growth in wealth and general development. Leaving aside our agricultural and timber resources, our mineral wealth in coal, oil, copper, lead, zinc, gold and silver, is not equalled in total amount by any similar area in the world. It has thus not been necessary for American capital to go outside of our own possessions to find lucrative mining investments, until in comparatively recent years. The end of our internal production and development is far from being in sight, but much of the cream has been skimmed and money available for investment has piled up into huge sums. Therefore the exploration and development companies are turning to foreign lands for other fields to conquer. As we all know, United States mining investments are heavy in Alaska, Canada, Cuba, Mexico, Central America and western South America, and these are the countries where United States mining investments are likely to predominate.*

What About San Francisco?

The average mining promoter considers San Francisco a dead town—not altogether without reason—but if we look forward a little, we may conclude that there is a reasonable probability of San Francisco becoming a great commercial and money center; and in that case, it is likely to become an important center of mining and development companies, particularly those operating in regions bordering on the Pacific. It may be noted that it is already an important official mining center for mining companies, with chiefly outside capital, and for mining engineers, chiefly out of jobs.

John W. Foster some years ago predicted that the Pacific Ocean would develop an extensive commerce and that the great

* Lincoln Hutchinson, ''The Panama Canal and International Trade Competition'', Macmillan Co., 1915.

impulse to this end would be the awakening of China. With the development of this great empire will come the demand for manufactured goods, and if we take no action, this may be largely satisfied by Japan and Europe; but if we build up a mercantile marine, we would naturally participate predominantly in this commerce, especially as our relations with the great Oriental republic are of a very friendly character. Should this occur, San Francisco may become a great mining center; for with commercial growth, there will be growth in wealth, and wealth must be invested to be productive. In this matter, the Panama Canal may be an adverse factor, for much shipping will go direct from New York to the Orient.

Since we have just hauled down the only mercantile marine flags of importance that we floated on the Pacific, this predicted growth of our Pacific commerce may be received with skepticism in shipping circles, but it is inconceivable that the American people, when once the facts are plainly before all of them, will allow all of the prizes offered to slip from their grasp.

H. T. Liang, a Chinese mining engineer, came recently to this country on a commission from his government to investigate our mining and metallurgical methods. In an address before the San Francisco Commercial Club, he said in part: "One of my great hopes in visiting America this time is to call your attention to the wonderful opportunities of mining in China today, and to urge that you do not allow them to slip. America once sent invitations to financiers and mining experts in Europe and she has profited by their response. Today China sends similar invitations to financiers and mining experts in your great country, and hopes that you will respond by coming to share with us our natural resources. Such a response will be heartily welcome, and will prove, I am sure, not only a source of great financial gain to you and to us, but also an added factor to strengthen the cordial relationship already existing between the two countries."

Dr. E. E. Pratt, chief of the U. S. Bureau of Foreign and Domestic Commerce, has approved a plan for the development of trade with China, initiated by Minister Reinsch and Attaché Arnold at Peking, as follows:

A well-capitalized American bank is necessary to American trade advancement.

China offers splendid inducements to American capital in mining enterprises, especially in tin, zinc, antimony, lead, coal and iron. Hunan Province, the most accessible of the richer mineral areas, is a particularly inviting field for investment.

There then follows the enumeration of many articles of manufacture which would find a ready sale.

However, the latest information concerning the mining laws and regulations of the new republic, and their actual enforcement in practice, does not at all correspond with the above expressions; and it is therefore to be presumed that more liberal laws and regulations are being drafted.*

WHAT IS THE MATTER WITH PROSPECTING?

As the finding of new mines is the most essential feature in the success of exploration and development companies, a consideration of prospecting is pertinent. Much has been published in our mining journals on this subject in the last three years, and the following is rather an abstract of the views of various engineers than the presentation of my own views. Perhaps the most picturesque commentary on the present condition of prospecting is that from the pen of T. A. Rickard, as follows:†

"The day of the illiterate digger is gone; the ore bodies that outcrop in plain sight have mostly been found; the search for mineral wealth has passed to the man who can make scientific inferences. The economic geologist has arrived. In consequence of the rapidity and ease of modern transport, the discovery of a single promising outcrop is followed by the 'location' or 'denouncement' of the entire area for miles, excluding the old-time prospector at once. Then one or two resourceful companies, by option or purchase, acquire large tracts and set to work to test the ground under the direction of experienced mining geologists. Such companies still believe it is cheaper to buy eggs and hatch them than to buy hens. They have learned that the buying of ore reserves is not a sure thing, while it also absorbs large lumps of capital.

"We doubt if the old spirit of adventure is dead; it has passed from the prospector to his next in command, the mining engineer. In the most remote corners of the earth he is to be

* "Mining in China", Mining Press, Sept. 18, 1915.

† Mining Magazine, March, 1914.

met. When a cablegram reaches London with the news that a rich find of ore has been made anywhere from China to Peru, from Siam to Alaska, at once syndicates are formed and technical leaders are forthcoming. No; it is not that. The geographic possibilities are becoming exhausted; the virgin areas are becoming few. The cream has been skimmed from the milk. Many of the great finds of the past have been purely accidental; a prospector stubbed his toe against the top of a treasure vault; a digger has awakened to find his pillow rough with gold. Discoveries as fortuitous are common in the records of mining. Of necessity they are becoming more and more infrequent. The gold-outcrop that catches the rays of the setting sun and hits the explorer in the eye, as it were, has been dynamited and milled long ago. It remains to seek for the ore bodies that are covered by the jungle of the tropics or the tundra of the sub-arctic regions; to find those that have been leached at surface or faulted out of their orderly sequence; to uncover the low-grade deposits that the old prospector disdained and to re-open the old workings in which he lost his geologic way. Here is where we get the true answer to this inquiry. The day of the prospector is passing because his success depended upon the discovery of ore so rich that he and his comrades could work it. Now that the superficial rich deposits have become rare, he can only expect to find deposits so low grade as to be unprofitable to his own limited means of exploitation. He finds something that is of no use to him; hence he is at a great disadvantage in selling it to those to whom it is of use. In other words, his independence is gone. He is dependent now on the mining engineer who scouts for the capitalist."

Prospecting from the London Point of View.

Probably no man is better informed as to the prospecting undertaken by London companies than R. Gilman Brown, who is the consulting engineer of several strong and successful English companies operating in Russia. Mr. Brown writes:*

"I cannot speak for conditions in the United States, but so far as London goes there are several venture companies here who devote a good deal of expense to developing prospects. As to finding prospects, that is a difficult matter for a company to

* Mining Press, San Francisco, July 17, 1914.

embark in; at the same time I know of more than one London syndicate that has sent out men into promising regions. Looking at this from another angle, there are several companies in England owning large tracts of country abroad, supposed to be mineralized, that have been successful in carrying on organized and scientific prospecting within their areas, maintaining specifically a geological and prospecting staff for this purpose. I can cite the Ashanti Goldfields as one of these companies, whose prospecting work, under the scientific management of Mr. Justice, has already resulted in the discovery of Justice's Find. The Kyshtim Corporation, under American geologists, has been doing the same work successfully in the Middle Urals, Russia; and the Tanalyk Corporation has been working on similar lines in the Southern Urals. All of the above companies, and I think most companies of this class, have had as a basis, discovered mines which they were either developing or operating. I rather tend to the belief that in order to justify the risking of capital in prospecting work, the general control of it should be under a trained geologist. This does not eliminate the prospector, but merely puts a man over him. I am strongly of the opinion that prospecting methods can be vastly improved, waste work eliminated, and fewer good opportunities lost, by expert geological control."

The following expresses the views of S. J. Lett, an English engineer:*

"There is always a demand for new mines, but as the greater part of the world has been explored in a more or less thorough manner and probably most of the more readily recognized deposits have been discovered, it is evident that future prospecting must be of a more thorough character and carried out in a scientific manner by men who have specially qualified themselves for this work. These remarks apply equally to the discovery of new mines in the jungle and of new ore bodies in the mine. It is evident after due consideration, that what is wanted is a new type of prospector. This new type will be a man who has had a thorough scientific training, who is a geologist and understands minerals and ore bodies, their mode of occurrence and genesis.

* Stephen J. Lett, Mining Magazine, May and Sept., 1913.

"The valuable discoveries on old abandoned claims reported from Australia and elsewhere, from time to time, indicate the necessity for a closer study of other old mining districts in the light of a later and better knowledge of ore deposition, and also in view of the greatly improved metallurgical methods, for many refractory rocks of former days would now be classed as ore and yield substantial profits upon treatment.

"The proved recurrence of zones of richness and poorness (apart from secondary enrichment or impoverishment) of gold and other deposits, points clearly to the necessity for a more thorough investigation, on modern lines, of unpayable outcrops in mineralized districts, for it is quite illogical to suppose that all lodes have been conveniently eroded to a point where their payability or non-payability can be determined by surface sampling. The Treadwell mines of Alaska are prominent examples of mines that have passed through rich and poor zones, followed by further richer zones at greater depth.

"In the older district of Kolar, the most important event (1912) is the improvement of the ore on the deepest levels of the Champion Reef mines, promising to revive its earlier glories. On the 43rd level in the Carmichael section, the lode averages 25 dwt. across six feet. At the Hutti mine, in Hyderabad, the deeper exploration at 2000 ft. has revealed the presence of profitable ore.

"The Great Fingall, in Western Australia, produced 75,000 pounds sterling from 30,000 tons of ore when the first lens was cut at 150 ft. The mine was within an ace of being abandoned, when fresh capital was raised and sinking continued, and a fresh lens cut at a depth of 400 ft. This continued until 1500 ft. before pinching out and yielded 6,700,000 pounds sterling from 1,773,000 tons of ore; but they had not done yet, for after sinking a further 740 ft. through the country a new orebody was found, and this has been developed to a depth of 2500 ft. from the surface.

"Deposits in andesite are not usually expected to continue to great depths, but the Braden mines, situated in the Andes, seem likely to be an exception. The copper ore occurs as vein filling in the fractured andesite. Parts of the deposit occupy an old fumarole, and the copper deposits are essentially primary.

No. 4 level was already 2500 ft. below the outcrop in July, 1911, and enormous quantities of ore, assaying 2.7% copper had been developed.

"There is a good deal yet to be learned about the application of geology to prospecting and mining, but much is already known, and, that we do not know all is no adequate reason why full use should not be made of the knowledge that we already possess. It is the practical application of geology that killed the old idea that true fissure veins extend to an unlimited depth and practical geology will help in the future just as surely to extend the limits of old deposits and to find new ones."

E. Walker of the Mining Magazine writes:* "Two or three London groups have on occasion embarked on prospecting work, and sometimes with excellent results, as at Mysore and Ashanti. Most of these houses are out of touch with the spirit of enterprise required for speculation on a surface indication, and the engineers associated with them, being chary of risking a failure, do not care to recommend a scheme unless it amounts to providing the necessary working capital for extracting known ore. The same caution is usually displayed by companies that have made fortunes out of mines, and wish to continue their organization after the exhaustion of their properties. Two recent examples will suffice. In the first case, an exploration company formed in America, reports that several hundred proposals have been examined, and not one proved suitable. In the second case, a company owning what was once a great gold mine, has investigated sixty proposals with no better luck."

Lett comments on this: "These remarks are surely an argument in favor of prospecting and of scientific prospecting. I think that the promoting houses are not so lacking in enterprise that they will look at only proved propositions, nor are their consulting engineers afraid to advise a fair risk in prospecting, as a fair risk, not as a wild gamble, when there is any promise of finding mines, provided that they like the mining laws in a country and their principals can obtain concessions on favorable terms. The fact is that concessions are increasingly difficult to obtain, and the governments want too much of the prospective profits, while taking none of the risks. Either this or labor is

* E. Walker, Mining Press, June 21, 1913.

short, or there is no security, all of which facts have to be weighed by the consulting engineers of the promoting houses.

"The several hundred proposals rejected by the American company only indicate that the proposals were unsuitable, not that some of them were not mines in the making. A certain eminent engineer did not think much of the Rand at one time. That great gold mine is not yet quite a thing of the past, and of the sixty proposals, were not some withdrawn, and were not others possibly sound small propositions? However, all this only points to the want of more prospecting and on more scientific lines; the mines are wanted, they probably exist and grub-staking will not find them."

The following is an abstract of remarks by F. H. Hatch,* on the relation of geology to mining. Mr. Hatch has a distinguished record in South Africa, Canada and elsewhere. He says:

"In the province of metal mining, mining geology comprises the study of the ore deposit; its lithological environment, its enrichment and impoverishments and their cause, and finally the faults and dikes that traverse it and their effect. As a result of such investigations the mining geologist is enabled to trace the outcrop of the deposit; to trace and define the ore shoots; to predict, as definitely as the evidence will allow, their downward extension; to outline the scheme of development and method of mining best suited to their shape, size, dip and pitch and having regard to any existing dike or fault disturbance; to determine the amount and value of the ore immediately or prospectively available; and from the nature of its mineral association to suggest the necessity, or otherwise, of eliminating the gangue by some form of ore-dressing or concentrating machinery; and, finally, to give a preliminary opinion, based on mineral composition, as to the docility or refractoriness, as the case may be, of the ore in regard to metallurgical treatment.

"It is evident that the examination of a supposed mining field, or of a lode or ore-body on which nothing but prospecting work has been done, is essentially the work of a mining geologist.

"In the case of a fully developed mine, in which the whole, or practically the whole, of the available ore is blocked out for

* Presidential address before the Institution of Mining and Metallurgy, London, 1914.

stoping, or at any rate is developed by drifts extending from end-line to end-line at the lowest levels permitted by the dip boundary of the property, the requirements are somewhat different and a mining engineer is required. Here what is wanted it not so much the drawing of inferences from the geological environment of the ore, but a correct appraisement of the net profit obtainable by its extraction with due regard to the economic conditions prevailing. In this case, apart from the estimation of ore-reserves, a consideration of the most suitable means of extraction and treatment and questions of finance are of paramount importance. An actual apprenticeship in mine management, supplemented by a long and varied experience of mine examination under the most varied conditions, are here the prime requisites for a successful evaluation.

"Similar differences exist in regard to the management of mining properties. Prospecting and exploratory mining are essentially the work of the mining geologist. Even in the normal development of a mine, questions often arise that cannot be solved without the aid of a sound knowledge of tectonic geology. It is true that on small mines, the mine manager is often expected to possess the knowledge of the mining geologist, the mechanical engineer, and the man of business. But big mines are, or should be, organized departmentally, and in that case are placed under the supreme control of a man chosen chiefly for his executive ability and power of organization, irrespective of other attainments. The machinery is, of course, controlled by a mechanical engineer, the reduction works by a metallurgist, the supply of ore by an underground superintendent or mine foreman; while the exploratory and development work is best superintended by the mining geologist. Surveying and sampling are natural adjuncts of the mining geologist's department. * *

"It must be evident, I think, that the point I wish to make is that the role of geology in mining is more important than is generally conceded, and that a recognition of this involves either an extended geological training for the mining engineer or a relegation of a portion of his functions to the mining geologist who has been trained underground."

Hatch mentions also, as showing the value of geological work for exploratory purposes, how a great coal field buried deeply

under Mesozoic and Tertiary strata in England was predicted by an English geologist and subsequently proven by drilling.

Another example noted is applied to reef deposits of the Rand Banket, the sub-outcrop or apex of which was traced under a cover of later unconformable beds. The result of this geological survey of the area between Boksburg, the Springs and Heidelburg, in South Africa, was to add to the Witswatersrand gold field an enormous area of mining ground.

However, we all know that nearly all of the larger mining companies employ mining geologists to assist their engineers in development work and it goes without saying, as Hatch and R. Gilman Brown note, that the exploration of concessions and new fields is best conducted by them.

Views of American Engineers on Prospecting.

The conditions of mining are so different in the United States, Alaska and the Philippine Islands from other parts of the world that the point of view of the American engineer, as concerns United States possessions, is correctly and necessarily different from those of his colleagues across the water. In most countries where the English companies are operating, it is possible to get hold of tracts of land, estates or concessions, and be allowed a liberal time to determine if the mineral showings found thereon are worthy of development. In our country, where such opportunities are seldom offered, individual prospecting on the prospector's own initiative seems to meet the conditions best. Consequently, the development companies, having no areas of sufficient size, except as to iron and coal lands, to warrant the employment of a mining geologist and assistants to prospect the same, incline rather to sending scouts at frequent intervals over the mining fields; or in many cases only examine such more or less developed prospects as are presented to them. On the other hand, nearly all the large American companies employ mining geologists to a greater extent than do English companies in the geological study of developed properties. It may be noted also that the Guggenheim Exploration Company is now doing exploration work in Alaska.

J. Parke Channing* writes: "The searching for new mines is a more or less hazardous business. One may take ten different

* Mining Press, Jan. 24, 1914.

prospects, spend money in developing them, and be extremely fortunate if one of them turns out to be a mine. To do this kind of work requires a large capital, and in America we have such companies as the Guggenheim Exploration, the General Development Company, and the United States Smelting, Refining and Mining Company, that do this kind of work."

The following remarks by the Mining Press,* however, indicate that the United States Smelting, Refining & Mining Company, in 1913, did not gamble much on the development of prospects. The Press states that during 1913, some "639 properties were submitted to the engineering staff, all but 101 were rejected on examination of data and reports, 82 of the remainder failed to pass preliminary field-examination; and out of the remaining 19, two oil properties were taken over, and a long-time option secured on an interest in a third. Evidently the complete answer to 'What is the Matter with Prospecting?', the interesting symposium published in the Press in 1914, has not yet been found, when out of 639 properties there is not discovered a single metal prospect worthy of development. It is undoubtedly true that there has grown up a disposition to eliminate the natural mining risk in taking up new ventures. Just what is the reason for the attitude of our development companies it is hard to state. Is it not possibly because geological conditions are so well known? The possibilities and probabilities in almost every mining district are perhaps so well classified and card-indexed that it is an exceedingly difficult matter for the prospector, or group of claim-owners, to bring in anything that is really new. Whatever it may be, there hardly exists anywhere a more hopeless task than lies before the owner of undeveloped ground seeking to raise capital in Eastern financial centers."

The view-point of the vice-president of a large exploration company as to conditions in the United States is expressed as follows:† "A large amount of money is being used continually for finding and developing prospects. As to the adequacy of the amount it is extremely difficult to judge. The facts seem to warrant the belief that the surface deposits and the more

* Mining Press, San Francisco, April 10, 1915.

† Mining Press, July 17, 1914. See also remarks in same article by other engineers.

easily found rich mines have been discovered; and that, therefore, prospecting for and finding new mines costs materially greater sums than in the past and also necessitates a somewhat wider vision, as the big new mines that have recently been found are mines in which, what is now (through the advance of mining and metallurgical skill) highly profitable ore, was not so very long ago uncommercial mineral. I do not believe in direct government aid to prospecting or prospectors. The aid that the government can give to this class of work is:

"1. Passing understandable and adequate mining laws, so insuring the title of claims legally acquired; simplifying the rulings of the Land Office and prohibiting the passage of retroactive legislation and Land Office rulings.

"2. In furthering education in the art of recognizing valuable minerals and mineral products.

"Prospecting, economically conducted, is bound to be a matter for individuals. No corporation can require from its employee the endurance of the hardships which are cheerfully undertaken when the gain to be made is his own or to be shared with a few individuals, all of whom are known to him. It depends on how much the individual prospector can be improved in knowledge of commercial mineral products, their occurrence, and the wise expenditure of money, as to whether the available funds will prove adequate to the finding of new mineral deposits or not. My experience tends to show that 95% of the owners of undeveloped mineral properties put an entirely prohibitive price upon their possessions. The value of undeveloped mineral lands is one of the most difficult values to determine, and consequently the imagination and cupidity of their owners have free rein, and the price that they fix for an entirely indefinite value bears no sort of relation to the risk that has to be run. The direction in which I see a chance for an improved market is the realization by the owners of undeveloped mineral land, that if they are not willing to take part of the risk, they should ask the people who are willing to put up the capital to develop their property, a price commensurate with the money that has been spent in locating the property." E. H. Nutter and E. G. Spilsbury in the same journal likewise emphasize that the price of undeveloped prospects should bear some relation to

the amount of money and time that the prospector has expended in finding and locating the prospect.

It may be noted, in passing, that most of the difficulties indicated above for development companies in the United States would be eliminated if prospecting concessions were granted with the right to locate valuable deposits when found, when the lands are government property; and a long option given, with an agreement for the owners to participate in profits, when the lands are in private ownership. It must be admitted, however, that such changes as would be required in our laws to permit of concessions, so common in other lands, are not likely to be made; and that too often the owners of private lands are suspicious of any arrangement that does not bring in specified amounts of cash.

Views of a Canadian Engineer.

The conditions under which exploration companies must operate in Canada are not essentially different from those in the United States, inasmuch as prospecting concessions except as to dredging, oil and coal lands are there also not available. The following article* from Vancouver by Percy Williams, now of Seattle, may or may not be representative of the general Canadian view:

"**About Exploration Companies.**—Most mining men and engineers, in the course of their professional work in every part of the world, are constantly brought into contact with prospective mines, practically undeveloped, yet bearing all the 'ear marks' of future profitable mines. It is seldom that the professional engineer has either the time or the funds to devote to the business of exploiting, developing, and financing such meritorious prospects; therefore, when they encounter such in their travels, while on other errands, they must either bid the possible embryo bonanza a fond farewell, or else make a note of its favorable and unfavorable characteristics and submit it to the head of some exploration or development company that is supposed to be engaged in this class of business. The chances are that he will be informed by the manager of such a company that they are interested only in the examination and purchase of developed mines with well-defined and profitable ore bodies.

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* Mining Magazine, London, March, 1912.

"Is it not a fact that none of the larger and richer exploration companies will consider any prospective mining enterprise, excepting in cases (like Porcupine) where surface ores are sensational? They want all possible risks to be taken by the original discoverers or operators, and are willing to pay a premium for the elimination of such risks as are inseparable from the development of even the most hopeful prospects. This premium is usually paid in the form of a payment for undeveloped and possible ore in such productive mines as may be purchased under advice of their engineers. For example, I note that during the past year one prominent American mining exploration company examined some 330 different mining propositions, and purchased two of these and negotiated for a third. One wonders what the figures are on the other side of the prospecting and examination ledger; whether the cost of examination of some 300 projects, in all parts of the world, which are supposedly developed propositions, is not far greater than could be consistently expended by half-a-dozen competent engineers in doing primary and conclusive development work on a large number of prospects whose surface showing is as good as, if not better than, that which obtains at the larger, more developed, and productive mines of the class to which the 300 were supposed to belong. Taking an average of $1000 for each examination of the 300, we have a total expenditure of $300,000 to disburse before we can make up our minds to pay, upon the advice of our engineers, $500,000 for one property, $650,000 for a second and $1,500,000 for the third, selected from a bunch of 300. In a nutshell, the idea occurs to me and may be stated in this way: would not this $300,000 paid in examination expenses accomplish more profitable results if properly spent in the work of prospecting for or of bonding undeveloped surface showings, and doing thereupon sufficient work to determine their merits or demerits in depth? Surely $300,000 would do a lot of prospecting and preliminary development, and, if such work resulted favorably in some cases during the year, such successfully matured prospects could be purchased for a few thousand or even a few hundred dollars, as against the hundreds of thousands necessary to acquire proved mines with profitable ore reserves. Scattered through the west of the United States and in Canada and Mexico are countless

such surface showings, as yet unproved because of lack of capital. The same condition also obtains in every other continent of the world.

"The large exploration and mining companies are frank in their expression of desire for the acquisition of meritorious mines, and spend fortunes annually in examination of many supposedly such, submitted to them from all quarters of the globe. As a matter of fact, it is a good deal of a merry-go-round, in which the engineers of the different large syndicates take turns in examining the same properties for their respective clients. Will a review of the subsequent history of such high-priced acquisitions always make delectable reading for some of their purchasers? Are not some of these large companies finding that extreme conservatism is expensive?

"It is not to be assumed for a moment that, even with the best of judgment, technical knowledge, and experience to aid him, any mining engineer can do development work on, say, ten different surface-showings or prospects, and have such work result in the demonstration of profitable mines in each case. We all know that such an engineer will be doing well if he can develop only two good mines from his selection of ten prospects. But these two mines, thus obtained, are quite likely to cost much less, all told, than the $300,000 expended in the examination work alone of a great development company each year.

"It seems to me that one of the principal reasons that the development of prospects has proved so generally unremunerative is because such work has been left by the large, experienced operators to the inefficient speculator and promoter, to the small fry, the mining camp store-keeper and the small city merchant. This latter class have done their best, but through their inexperience and because of their limited capital they seldom succeed in making a mine out of a prospect, and therefore the business and the district fall into disrepute. The big experienced operators and exploration companies thus conclude that that branch of the mining business is too risky, and so confine themselves to the conservative examination and re-examination of second-hand mines that can show a reserve below the surface. * * * * It will be noted that I am arguing for less conservatism and more mining."

A remedy for the merry-go-round examination of mines, referred to by Williams, has been considered from time to time, but nothing of a practical nature has resulted. The chief difficulty is probably that the most important reports belong to corporations, who often do not care to give out any information. The Mining Magazine of London has, however, just launched "The Mining Register", which is said to be satisfactory to some of the leading English corporations. "The Mining Register" proposes that engineers shall file statements of the districts that they are familiar with and names of mines which they have examined, but no reports are actually to be turned over to the "Register". Then when an inquiry comes in, the name of the engineer or engineers who have made the reports is furnished. This plan may result in good business both for investors and for engineers, and save much duplication of examinations.

In conclusion it may be noted that exploration companies do not primarily go into business in order to explore and develop; they go into business to make money. Exploring and development work is a continual expense without any revenue; hence, to continue business the company must soon drift into operating properties or into investments. As a matter of fact, they do both, and thus become profit-paying concerns. When in this condition, the directors should no longer give their whole attention to exploration solely, which must then become a minor factor, as it should if the corporation is to make money and continue to exist; and such companies naturally tend to become operating and investment companies pure and simple, and the exploring and development work is only necessary when developed ore bodies or other deposits or other investments are not available. These conditions will vary with each company, and are reflected in the status of affairs of the large exploration companies as they are today. In fact, if the engineers who have criticised the tendency of development companies to look at developed prospects only, and because they hesitate to spend money on a mere surface showing, should themselves form a development company, it is clear that in a few years this company would be doing about what the exploration companies are doing today, or else be out of existence. The directors of our successful exploration companies are hard-headed men. They

have had many and diverse experiences with prospects and prospectors, and the conservative course that any such company finally adopts is probably the only one that leads to successful business. Such companies cannot explore profitably without having concessions. In such places where concessions are possible, they do explore extensively, but in North America, where concessions or exclusive rights on large tracts are not usually available, the tendency is and should be to let the other fellow do the exploring; but it does not follow that the large companies would not do better if they did more developing of good prospects on bond. However, the United States is today producing a greater tonnage of all mineral deposits, excepting quicksilver and possibly some other minor metal, than ever before, which all goes to show that the present methods of acquiring mining property are not so bad after all, inasmuch as so far as the general public is concerned, the products are all that are desired, and the method of producing them a relatively unimportant matter.

FLOTATION OF MINING COMPANIES.

A development company or a small syndicate having found a mineral deposit worth operating, how shall it proceed to organize the company? An answer to this question, more particularly for inexperienced engineers and promoters, may be found in two lectures delivered before the senior class of the School of Mines of the University of California, in 1908, by Henry A. Butters* and is especially applicable to American conditions. The following is an abstract from Mr. Butters' lectures, with a few changes in form to bring out the progressive development from a surface showing to a mine.

Companies are often created and business launched without the operation of outside capitalists. A case in hand applicable to this discussion would be where four or five persons might wish to join for the purpose of opening up a prospect owned by one of their number. We will suppose that A owns the prospect; B is willing to contribute $1000; C, $500; D, $300; and E, $200; altogether $2000.

In a case like this, all that is necessary in forming the company is to decide what relation the prospect is to bear to the

* Mining Press, May 2, 1908.

total capitalization, and fix an arbitrary sum as the capital stock. We will assume an agreement that this prospect is to rank for one-quarter interest in the issued stock of the undertaking. A basis would then be the following:

Total capital stock	$25,000
Reserved in the treasury	5,000
Total available	$20,000

A, the owner of the prospect, will have one-quarter of the available stock, leaving $15,000 in stock to be distributed pro rata among B, C, D, and E. The total amount of cash involved is $2000. B pays $1000 or 50% of the amount, C pays $500 or 25%, D pays $300 or 15%, and E pays $200 or 10%.

For convenience we will assume that the stock is divided into shares of $1 each. Then

B's portion would be 50%	7,500 shares
C's portion would be 25%	3,750 "
D's portion would be 15%	2,250 "
E's portion would be 10%	1,500 "
Total	15,000 shares
A's interest ¼ of 20,000	5,000 "
Total shares issued	20,000 shares

Let us suppose that the prospect, opened up by this small company or syndicate, develops so promisingly that additional capital is warranted. The present owners would then all be promoters. When trying to interest capital, do not think to hold control of the enterprise. When a capitalist puts money into a venture, he expects and demands the controlling authority in matters of policy, the composition of directorates, etc. If you insist on managing the whole affair yourself, you will be unable to enlist assistance from capital. What you ought to do is to work into a partnership with your capitalist, with the certainty that if you make good in working for your joint interests, your abilities are bound to be recognized; while if you are unable to handle the enterprise in a satisfactory manner, the capitalist will and ought to insist that a competent man be put in charge to avoid wrecking the entire enterprise.

To begin with, you want in cash, on the basis of the prospect being worth $5000, required for further development,

$10,000, and for contingencies $5000; altogether, $20,000. Here is the basis for the company:

Capital stock		$100,000
Stock to capitalist for contribution of $20,000	50,000	
Promoters or stockholders of the first prospecting company	25,000	
Treasury stock	25,000	
Total in dollar shares	100,000	

Let us further suppose that the deposit in question develops into a mine and that large capital is required. If this is not available among the present stockholders, the company as a whole must again assume the position of promoter. The net value of the ore developed has been determined by the examining engineer to be $500,000. We will suppose a $1,000,000 gross in sight. A working plant is required, to cost $250,000, and the cost of mining and reducing the ore would be $250,000. This would leave a net product of $500,000, plus the plant, which, unless the ore continued in sufficient quantity to make its operation profitable, would become a negligible quantity and should not be taken into account. In order to go to the public for money, the basis of capitalization would be about as follows:

Price of mine	$350,000
Plant	250,000
Working capital, cash	50,000
Total cash required	$650,000

A fair capitalization of such a proposition would be 1,200,000 shares, out of which there must be sold to the public 1,000,000 shares, par value $1.00, at 65c. per share, to produce $650,000. The promoter or the selling company would be entitled to 100,000 shares in addition to the price of the mine, leaving 100,000 shares in the Treasury as a reserve.

And now just a little explanation as to why the capital has been estimated at a million and the selling price of stock at 65%. In dealing with commercial, industrial, railway, and kindred enterprises, there are usually tangible bases for computing not only legitimate earnings for, but also amortization of, all securities. In mining, the situation is generally the reverse, and

this is the case in the illustration under discussion. There is an element of risk to be reckoned with, and the investor must have a larger margin for possible profit to compensate therefor. Accordingly, the shares are sold at 65c. instead of at par; the inference being that if the ore should continue as expected beyond the visible supply, and other probable ore bodies be encountered, the value of the stock would increase to par. Manifestly, as the stock is to be sold at 65, there must be a sufficient amount to realize the requirements at 65, and also to provide the two amounts of 100,000 for the promoter and 100,000 for the Treasury reserve. All of this can only be accomplished by making the amount $1,200,000.

More recently, the plan has been frequently adopted of issuing bonds, convertible debentures or preferred stock, to the amount warranted by the net value of the known ore reserves, as explained in detail in the following article on Mine Valuation and Mine Finance by H. C. Hoover,* which is one of the clearest statements in print of the underlying principles that should govern the flotation of mining companies. Mr. Hoover emphasizes in a partly developed mine (and practically all substantial promotions are of mines of this character) the inherent difference between "proved ore" or "profit assured" and "undeveloped ore" or "prospective value"; "probable ore" belonging partly to proved ore but mostly to undeveloped ore. With the proved ore as a basis, he would issue debentures to the value of the profit assured. With the prospective ore, he would issue stock or shares.

Mr. Hoover writes: "While economic factors such as the price of metals, extraction, equipment, working cost, etc., are involved in any question of profit assured, yet the factor of greatest uncertainty is a geological one, namely, the continuity of the ore through a mass of rock beyond the surfaces exposed and sampled. We can relegate the first series of factors to constants, but the geologic factor is a variable, to be gauged approximately at most. My own view is that the risks involved in this variable can best be expressed in terms of the actual distance assumed for the extension of ore beyond the face sampled. The actual distance to be taken in any particular

* Mining Magazine, London, October, 1912.

case is dependent on the character of the deposit, experience of the mine, and so forth. It may vary all the way from 10 feet to 250, but, in any event, the statement as to what distance is assumed affords a far better definition of the risk recognized, than any scheme of 'probable ore' or such corollary remarks as 'proved on three sides' or 'on two sides', etc. The expressions 'proved ore' and 'profit assured' can be made synonymous by the introduction of such constants as cost, extraction, price of metal, etc. Any given statement of profit assured, in order to define the weight given to the various factors, must include information as to the constants introduced into the calculation. In other words, any statement of profit assured must be extended to give:

1. The tonnage of ore.
2. The maximum distance in feet that the ore has been assumed to continue beyond a sampled face.
3. The average value.
4. The percentage of extraction assumed.
5. The working cost.
6. If other than a gold mine, the price of metals assumed.
7. The cost of new equipment necessary to recover the profit.
8. The loss of interest involved during the period necessary to recover this profit.

"Profit assured after a proper consideration of these factors, is security worthy of a debenture or a bond redeemable out of this profit.

"The 'prospective value' outside of the proved areas is in no case capable of representation in quantities; in the last analysis it degenerates into a matter of individual opinion, in which the governing factors are a blend of psychology and geology. I do not believe that the value of a mine can be determined or interpreted in money by any algebraic formulae, no matter how complicated. Those who attempt to do so must ignore the insistent speculative factors that are involved in the expressions 'proved ore' and 'profit assured'. In this matter, also, there is a good deal of the personal equation and metallurgical, economic and geologic risk, even when the data are taken with the greatest care and intelligence.

"In any event, there is a distinct and broad line to be drawn between these two items in the valuation of any mine, and it is at this point where it is possible to adjust the capital on its initial presentation to the investor so as to represent fairly well these two distinctions. The investor in, or purchaser of, a mine may be expected certainly to pay an amount for the mine represented by the profit assured (adequately based), and also to pay something for the prospective value. Therefore, if in the capitalization of a mine we represent the profit assured by debentures, redeemable in principal and interest out of such profit, and we assign the whole of the share capital to the prospective value, we shall, in a broad way, have distinguished in tangible finance the difference of the risk involved. In such a case the share capital is wholly speculative and, in effect, represents the future of the property outside of the developed ore. It becomes immaterial as to how many shares represent the prospective value, for it becomes simply a convenience in the adjustment of the various interests involved. If, therefore, the promoter or the vendor, in offering the mine to the public or to the private capitalist, whether he offers it for sale or merely desires to secure working capital, would formulate his finance on these lines and offer debentures for the money subscribed, he has a right to a considerable proportion of the share capital.

"The promoter or the vendor usually approaches the capitalization of a mine from one of two points: either to sell the property for cash or cash and shares; or to secure working capital for its development and equipment. In the first case, the investor or the capitalist has the right to demand that the vendor or promoter shall be content with the cash realized from the debentures, less working capital necessarily left in the company's treasury, and with a portion of the shares. Inasmuch as the factors involved in the calculation even of 'proved ore' are to some degree speculative, the investor is entitled to a good deal more interest than the 5% that he can get on gilt edge securities. Consequently, he should have such a debenture at 6%, with some discount, and also have a bonus in shares, and, as a matter of prudent and practical finance, equally beneficial to the vendor and the purchaser, such debentures should further be made convertible into shares. In the second case, where the vendor or

promoter is seeking only for working capital and where such working capital may be considerably less than the profit assured, then, if the mine should be capitalized on this basis, the promoter or vendor should himself receive debentures representing any residue of difference between profit assured and the working capital required, and there should be a proper adjustment of the share interests on this basis. * * * One advantage of such a method of capitalization is that it often forms a much easier basis to negotiate as between capital and the vendor, and many a negotiation, practically hopeless from the point of view of division of share capital alone, becomes quite feasible on the introduction of a debenture redeemable from the profit assured. Such broad lines of division are practically represented in the great railway systems in the matter of their issues of debentures (or bonds) and common stock * * *.

"The method just outlined has the important advantage of differentiating the substantial portion of the mine-value from the entirely speculative portion, and also differentiates the mine of substance from the development gamble. It is in the misleading of the investor over this last type of mining (which is legitimate enough in itself) that just complaint lies. Too often the prospect is offered as a mine, or share capital that is largely speculative is offered as of proved value. The capital of the undeveloped mine should all be shares, and as such would be on a parity with shares in a mine carrying an assured-profit debenture. In the initial stages, the debenture would be in itself the evidence of substance. By the time the debentures are redeemed, the mine will be standing in public estimation fairly on its own merits. A further advantage, from the public point of view, lies in the fact that if the promoter or vendor underestimates the capital necessary to bring the mine to production, he will have to pay the penalty by the loss of his entire share-interest through the foreclosure of the debentures, or, alternatively, to supply the money to prevent such an event."

The application of this plan is not new in American mining finance, as evidenced in the flotation of the porphyry coppers. The Mining Press* says of these:

* Mining Press, Feb. 20, 1915.

"The strength of Alaska Gold Mines Co.'s 6% convertible debenture bonds, selling around $115, has directed attention to the excellent records made by the convertible bonds of the porphyry group likewise floated by the banking house of Hayden, Stone & Co. Nevada Consolidated, Ray Consolidated, Chino, and Utah Copper all issued 6% convertible bonds. Nevada bonds cost $106 and sold as high as $300; the first issue of Ray bonds cost $105 and sold up to $200; Chino cost $110 and sold up to $200; Utah cost $110 and sold up to $220. Among the several achievements of the porphyry coppers should be noted the fact that they have made the convertible mining bond a popular security, combining investment and speculative attractions. Jay Gould made the convertible bond popular originally, a generation or more ago, in the days of his Erie campaign, but it has been left for the low-grade copper and gold mining companies, with their large ore reserves, to popularize that form of investment in the mining world."

MINING LAWS, MINING REGULATIONS, AND MINERAL PRODUCTION.

In undertaking exploration and development work in a foreign country, a company may consider first its past record of mineral production, but even if that is good may well hesitate when the laws and regulations are unfavorable and the government unstable. A brief review of the mining laws of various countries is therefore germane to the subject in hand. The following data, while very incomplete, give some notion of the laws and mineral resources of those regions most likely to interest American development companies.

United States and Alaska.

In many respects the laws are very liberal. Any citizen may locate any number of claims, provided mineral is found on each of them and the annual work required is done. But no claim is legal until a discovery has been made, and although thousands of claims are held without discovery, we all know that litigation often ensues when a really valuable discovery is made, unless the laws have been strictly complied with. Therefore it is impracticable for exploration companies to get exclusive permits to examine given areas of land, unless in private ownership, and about the only way to get mining property is

that now in use, as before described, of examining claims scattered here and there, and acquiring such as seem promising, by purchase. The prosperity of our large companies proves that business is profitable by such methods. Nevertheless, foreign exploration companies usually prefer other fields where more liberal laws prevail, coupled with the general belief that the Americans usually keep anything that is really good.

Lode claims are 1500 ft. long and 600 ft. wide, comprising about 20 acres of land. On each claim there must be $100 worth of labor expended each year until patented; when commercial values have been demonstrated and development work done to the value of $500, a claim may be patented. Placer claims are also 20 acres for one individual or 160 acres for an association of eight persons. Such claims must conform to the system of public land surveys, when the lands have been sub-divided. But one discovery of mineral is required, whether the claim be of 20 acres by an individual or of 160 acres, or less, by an association of individuals. A placer claim may also be patented.

While our laws are clear as to the manner of location of metals in lodes, the laws, and Land Office and court decisions, as to non-metallic substances are not so simple.* Alum, asphaltum, borax, diamonds, guano, gypsum, kaolin or China clay, onyx, soda (carbonate and nitrate), slate for roofing and building stone have been located under the placer law. Under the saline law, a citizen may locate one placer claim only, and the Land Office holds that the Saline Act applies only to deposits of chloride of sodium. In regard to potash, Lindley states that deposits of this mineral in the form of brine, and also true bedded deposits in connection with chloride of sodium, may be located as placers where the profitable element is the potash and not the salt; and in this case the general placer law may apply and any number of claims be located by the same individual or association.

In regard to phosphate deposits, which have been located both as lodes and as placers, and sometimes the same land located both ways, a recent decision is to the effect that where the phosphate occurs in layers in the sedimentary strata and where the line of demarcation between veins of such phosphate rock

* See Lindley on Mines, Edition of 1914.

and wall rocks is well defined and distinct, etc., it may be located under the lode mining laws. Nearly all known public phosphate lands have been withdrawn from entry.

Lindley concludes, from the various rulings of courts and of the Land Office, that land containing any substance, metallic or non-metallic, which possesses economic value for use in trade, manufacture, the sciences or in the mechanical or ornamental arts, if such substance exists therein in veins or lodes of rock in place in sufficient quantities to render the land more valuable for the purpose of removing and marketing the product than for any other purpose, such land may be appropriated under the law applicable to lodes. Following this opinion by one of the most thorough students of our mining laws, it would seem, in effect, that our present laws, based chiefly on decisions, amount to the same thing as the law of British Columbia, as to what may be located as lodes, or mineral in place; but in the latter case, we have a clear and simple law, which can be understood by any prospector, while in the United States, we require an attorney to tell us what to do.

The subject of the revision of the mining laws has been so much before the mining public in the last few years, that we are all tired of it, especially as no actual legislation of importance has been accomplished. This has been in part our own fault, according to report, as it seems that the mining fraternity has not stood solidly behind any recommendations from any source. However, there is good reason to believe that the united efforts of the Geological Survey, of the Mining and Metallurgical Society, of the American Institute of Mining Engineers, and other friends of mining will eventually result in our having a simple set of laws, which the ordinary mortal can apply in practice.

Coal is the subject of a special law, in virtue of which any citizen may enter any vacant coal lands, not exceeding 160 acres to such individual or 320 acres to an association, upon the payment of $10 per acre when the land is more than 15 miles from an operating railroad and $20 per acre when the land is within the 15-mile limit. No individual or association can make more than one entry of coal land. By the law of 1913, the values of coal lands are determined by the heat units contained in the

coal, by its thickness and distance from the surface. When these lands are more than 15 miles from a railroad, the price is doubled. By laws passed in 1909 and 1910, coal is reserved in public land sold for agricultural purposes, there being here a complete severance of surface and underground values. However, nearly all coal lands have been withdrawn from entry. In Alaska, no patents have as yet been issued to coal lands; but locations made prior to November 12, 1906, may be consolidated up to 2560 acres.

The difficulty in entering petroleum lands under the placer law is evident, as in most cases it is not possible to make a discovery until drilling has been done. Some relief has been granted in certain cases, but the necessity of a new law is recognized by every one.* In Utah, by the Act of August 24, 1912, the oil and gas in any public land entered for agricultural purposes is reserved by the government. Here, again, is a severance of surface and underground values, which, let us hope, will be extended to all forms of deposits, as was recommended by Director Smith of the Geological Survey, and has worked so satisfactorily in Mexico. There is little doubt but that the mining laws will be revised.

Production of the United States, Including Alaska, for 1912.

(Mineral Industry)

Gold, fine oz.		4,437,561
Silver, fine oz.		62,369,903
Copper, metric tons		563,260
Lead,	"	372,056
Zinc,	" (spelter)	316,368
Pig Iron,	"	30,202,568
Coal,	"	484,987,820
Petroleum,	"	29,906,416

The United States leads the world in the production of coal, iron, petroleum, copper and zinc, and in the manufacture of steel. In the production of silver, it is second only to Mexico.

Philippine Mining Law.

The mining laws† now in force in the Philippines do not differ materially from those in the United States, except in the lode claims being square in form, with all sides bounded by verti-

* See "An Oil Land Law", by George Otis Smith, and "The Placer Law Applied to Mining", by Max W. Ball, Bull. No. 90, A. I. M. E., 1914.

† Lindley on Mines, 1914.

cal planes. Hence the law of "apex" does not apply. There also seems to be no requirement for work being done on lode claims or placers before patenting, except the annual work, which apparently need not amount to $500.

All mineral deposits on public lands both surveyed and unsurveyed, are open to exploration and location by citizens of the United States and of the Philippine Islands. Lode claims must be as nearly rectangular in form as possible, bounded on all sides by planes extending down vertically. Mineral must be found in place on each claim and only one claim to one person or association of persons is allowed on any one vein. Each year, work to the value of 200 pesos must be done on each claim.

Coal lands may be purchased by citizens of the United States or of the Philippine Islands, when a part of the public domain and not reserved, not exceeding 64 hectares to one individual or 128 hectares to an association of persons. The price per hectare when within 25 kilometres of a railroad or navigable water is 100 pesos; and when land is more than 25 kilometers from such transportation, the price per hectare is 50 pesos. Coal lands must be taken in squares of 16 or 64 hectares, in conformity with the system of public land surveys.

Mill sites for milling or mining purposes not exceeding two hectares in area may be located on non-mineral land not contiguous to lode claims.

Concessions made prior to April 11, 1899, have been confirmed, but the owners were required to build substantial monuments at each corner of the boundaries.

Placer Claims must conform, when possible, with the system of public land surveys; no individual shall take more than eight hectares, and no association of persons more than 64 hectares.

Lands valuable for petroleum or building stone may be located under the placer mining laws.

Saline lands are sold to the highest bidder for cash, at not less than six pesos per hectare.

British Columbia.*

While the laws of British Columbia are an improvement on those of the United States, from the point of view of a de-

* See the annual reports of Provincial Mineralogist, Robertson, Victoria, B. C.

velopment company, they are similar in that no prospecting concessions are granted over any considerable area, except for dredging coal and oil lands. To prospect, any person, whether a Canadian or foreigner, over 18 years of age and any joint-stock company, must take out a Free Miner's Certificate, which is good for one year. The fee to an individual is $5, and to a joint-stock company, having a capital of $100,000 or less, the fee is $50; if capitalized for more than $100,000, the fee is $100.

"Mineral" means all valuable deposits of gold, silver, platinum, iridium, or any of the platinum group of metals, copper, iron, tin, zinc, nickel, aluminum, antimony, arsenic, barium, bismuth, boron, bromine, cadmium, chromium, cobalt, iodine, magnesium, manganese, molybdenum, phosphorus, plumbago, potassium, sodium, strontium, sulphur (or any combination of the aforementioned elements with themselves or any other elements), asbestos, emery, mica, and mineral pigments. Limestone, marble, clay or any building stone is not mineral. "Rock in place" means and shall include mineral (not necessarily in a vein or lode) that is, when discovered, in the same place or position in which it was originally formed or deposited; as distinguished from loose, fragmentary, or broken rock or float.

A lode or mineral claim is a rectangular piece of ground not exceeding 1500 feet square (about 51 acres). The four boundaries extend down vertically and there are thus no extralateral rights, except to certain old claims located under the former apex law, long since repealed. A free miner can hold by location but one claim on any one vein or lode, but may acquire others by purchase.

Lode claims can be Crown granted, when assessment work to the value of $500 has been done or when, in lieu thereof, $500 has been paid. This Crown grant conveys only the underground mineral rights, together with so much of the surface as is necessary for the proper working of the claim, together with all timber on the claim, to be used for mining purposes, which is meant to include all operations connected therewith.

Until Crown granted, assessment work must be done each year to the value of $100, or, in lieu thereof, $100 in cash may be paid to the Mining Recorder of the district.

Should the free miner do assessment work in any one year to the amount of $100 or more in excess of the required work, this extra work may be credited to ensuing years, so that all the work required for, say, five years may be done in the first year.

Mineral claims, when Crown granted, are subject to a yearly tax of 25 cents per acre, but when work to the value of $200 has been expended on the claim in the previous year, this tax is not collected.

A tax of 2% is levied quarterly on all ores and other mineral substances extracted, based on the net value of such ore at the mouth of the shaft or tunnel; but where ore-producing mines produce under $5000 in a year, half the tax is refunded.

Placer claims are of four classes, as follows:

Creek diggings: any mine in the bed of any stream or ravine; the length, measured in the direction of the general course of the stream or ravine, is 250 feet and the width, 1,000 feet.

Bar diggings: any mine between high and low water mark on a river, lake, or other large body of water. The claim is 250 feet square on any bar which is covered at high water, or a strip 250 feet long at high water mark and in width extending from high-water mark to extreme low-water mark.

Dry diggings: land over which water never extends; the claim is 250 feet square.

Precious stone diggings: any deposit of precious stones, whether in veins, beds or gravel deposits. The claim is 10 acres in size.

Special privileges are given to the discoverers of new diggings. Placers must be worked nearly continuously during the open season. A tax is levied on the product, as with lode mines, but when the product of any placer or dredge mine is less than $2000 for any one year, the tax for that year may be refunded on application.

Hydraulic and Dredging Leases may be granted for a period of not exceeding 20 years of unoccupied Crown lands

or of lands already lawfully occupied, but in the latter case the occupant or owner must be compensated for any damage. The areas or distances along streams shall not be more than the following:

In creek diggings on abandoned or unworked creeks, half a mile in length.
Hydraulic diggings, 80 acres.
Dredging leases, five miles.

The minimum rental for a creek lease is $75 per annum; for an hydraulic lease $1000 per annum; and for a dredging lease, $1000 per mile per annum.

Coal, Petroleum, and Natural Gas Claims cannot exceed 640 acres in a rectangular form, with boundaries running due north and south and east and west. The license fee for such a claim is $100 for one year and may be extended up to two years more.

Should the licensee discover coal, petroleum or natural gas upon the claim during the period of his license, he may obtain a lease of the claim for five years, at an annual rental of 15 cents per acre, and such lease may be renewed for a further period of three years, upon the payment of $100 for each parcel of 640 acres. If during the period of the lease, or within three months thereafter, the licensee can conclusively show that he has continuously and vigorously prosecuted the work of coal or petroleum mining, and has fully carried out the terms of such lease, he shall be entitled to purchase said lands, including the coal, petroleum or natural gas thereunder, at the rate of $20 per acre; or in event of the surface rights having been alienated from the government, he can purchase the coal, petroleum, or natural gas underlying such lands at the rate of $15 per acre; provided also, that, in addition to the rental or purchase price, there shall be paid to the government, as a royalty, 2½c. a barrel (35 Imp. gallons) of crude petroleum raised or gotten from such land.

The mining laws of British Columbia are better and more liberal than those of the United States in the following particulars:

1. In regard to lode claims, there is no apex law and hence but little, if any, litigation.

2. By allowing money to be paid in lieu of assessment work; and by allowing excess assessment work to count for future years, the prospector is better protected; and the amount to be paid is too large to allow any considerable number of claims to be held long as a speculation; also foreigners may locate claims.

3. By making all minerals in place subject to a simple and uniform law, all the trouble of how to locate non-metallic minerals is avoided, and litigation prevented. What is meant by the term "mineral" is explicitly defined. Fuels are given special laws, with prospecting licenses for a sufficient time to determine if the coal, oil or natural gas is or is not under the land, thus rendering it possible to prospect legitimately for these substances, which is not the case in the United States. What are practically prospecting licenses are also granted for dredging lands.

Production of British Columbia for 1913		Total Canadian Production for 1912
Gold, fine oz.	296,927	607,617
Silver, fine oz.	3,465,856	31,931,710
Copper, metric tons	21,080	34,213
Lead, "	25,119	16,226
Zinc, "		3,810
Pig Iron, "		927,484
Coal, "	2,171,682	15,485,377

British Columbia is as yet an undeveloped province, but the mineral resources are undoubtedly of great importance. Data of the mining laws of other Canadian provinces are not at hand. Eastern Canada* is especially noted for its copper-nickel, silver and asbestos deposits.

Mexico.

Mining property in Mexico† is understood to include only the underground rights and not the surface, except in the case of placers and superficial deposits.

Mineral oils and mineral waters, the country rocks, including stone for construction or ornamentation and the bog ores, ochres, etc., materials of the soil, such as sand, clay, etc., are included in the surface rights, and such lands must be purchased from the owners.

* See reports, Department of Mines, Ottawa, Canada.

† Chism. Trans. A. I. M. E., vol. XXXII, 1902.

Deposits of gold, silver, mercury, iron (except bog ore), lead, copper, tin, zinc, antimony, nickel, cobalt, manganese, bismuth, arsenic, precious stones, rock salt or sulphur must be taken up under the mineral law.

Any inhabitant of the Republic may undertake exploration work on public lands by giving notice thereof in duplicate to the local mining agent, in which notice the boundaries of the zone of exploration shall be accurately described. During the peremptory term of three months, counting from the date of the notice, of the permit, or decision of the mining agent, only such applications for a concession are admitted as may be presented by the prospector himself. In those cases where the mining agent may receive an expert report, under the responsibility of its author, in which the existence of subterranean gold-placers is indicated, the term of exploration may be extended up to one year for such placers only. Prospecting is not permitted in close proximity to towns, public or private residences, public works generally and fortified places. Foreigners are not permitted to locate claims or own real estate, without previous permission, within 20 leagues of the borders of another state. Any contract for rental of a mine made with a foreigner, for a longer term than 10 years, is to be reputed as a transfer of the property.

The mining claim is the pertenencia, 100 metres square, bounded by vertical planes. Any inhabitant may denounce any number of claims and hold the same in perpetuity, so long as the annual taxes are paid. The annual tax on each pertenencia is 10 pesos for gold, silver and platinum claims, and 2½ pesos for claims valuable for other deposits.

The Mexican government* purchases gold and silver bullion at an unvarying price. The value of the gold is $675.416 per kilogram, payable in gold coin or its equivalent; the value of silver is $40.915 per kilogram, payable in Mexican silver dollars. There is a coinage tax of 2% and a stamp tax of 3%. The value received for silver in reality varies, inasmuch as the value of the silver peso varies; but this does not concern the mining companies as to local payments, inasmuch as these usually are made in silver.

* N. H. Emmons, Trans. A. I. M. E., Nov. 1901, vol. XXXII.

The taxes on ores of gold and silver mined in Mexico comprise 2.6% of the gross value, as State and Federal extraction-tax, plus 4.5% as mintage-tax, or in all 7.1% of the gross assay-value, to which must be added the stamp-tax on the bill of sale of 0.6% on the net value.

There have been various increases in mining taxes by the revolutionary chiefs in different states, but it may be presumed that they are illegal, as they have not been sanctioned by a legally elected Congress and will presumably be repealed or ignored later.*

The mineral resources of Mexico are so well known that it is hardly worth while to go into detail concerning them. It is pre-eminent in the production of silver and bids fair to be in the production of petroleum. For the sake of comparison, we may note the production in 1912.

Partial Mineral Production of Mexico in 1912.
(Mineral Industry)

Gold, fine oz.	1,096,058
Silver, fine oz.	82,506,963
Copper, metric tons	73,637
Lead, "	109,717
Zinc, "	9,709
Petroleum, "	2,646,000

Conditions are thus good in normal times for the operations of exploration companies in Mexico, and no doubt many new enterprises will start up as soon as the government is again stable.

Japan.

Under the head of Japan may be properly included southern Manchuria, eastern Mongolia, Korea, and the islands of Formosa and Sakhalin.

In Japan proper,† foreign companies, formed in accordance with Japanese laws, may operate lode mines. Companies are required to send into the local mining bureau a yearly statement of all products mined and their value and to pay a tax of 1% of this value, as well as a ground tax of about 18 cents per acre for the land included within the mining property.

* "Mining Laws of Mexico Issued by Carranza", E. & M. J., Oct. 23, 1915.

† Weigal, Trans. Inst. M. & M., London, Dec. 1905.

The occupation of mining in Formosa is permitted to Japanese subjects only, and none but Japanese subjects can become members or shareholders of any mining corporation or association. The same rule as to the exclusion of foreigners applies to placer mining in Japan proper, but not in Korea.

Korea.

In Korea, any person desiring to engage in mining operations must apply for permission to the Minister of Agriculture, Commerce and Industry, submitting a written application accurately specifying the kinds of minerals that he intends to mine, together with a plan of the intended mining claim, and giving proof of the existence of the desired minerals in the claim.

The boundaries of the claim must be straight surface lines, extending vertically downward. The area of a claim cannot be less than 50,000 tsubo (about 41 acres) in the case of coal, and in the case of other mineral substances, not less than 5000 tsubo (4.1 acres); and in any case not more than 1,000,000 tsubo (about 826 acres), unless necessary for protection of public mining interests.

Private lands may be entered as mineral claims, due recompense being made to the owners of the surface for any damage caused by operation.

A royalty of one hundredth of the market value of the gross output must be paid to the government, together with a ground tax of 50 sen (about 25c.) per 1000 tsubo per annum, excepting for the first year, when the ground tax is 25 sen or 12½c. per 1000 tsubo.

Lode mining applies to deposits in place, of gold, silver, copper, lead, tin, zinc, antimony, iron, manganese, graphite, coal, petroleum, and sulphur.

Within 50 ken (= 300′) from public structures, roads, graves, temples, etc., mining may not be carried on without permission, and as graves are extremely abundant, and many natives claim some of these graves as being those of their ancestors, and since the prospective damage to said graves causes mental anguish, it is necessary to purchase said mental anguish, and this is usually easily done, I am told.

Within 300 ken (= 1800′) of Imperial houses or fortifications no mining operations may be carried on without permit.

A mining right may be inherited, transferred or mortgaged.

The placer mining laws of Korea refer particularly to gold, tin and iron sands. The size of the claims and nearly all the restrictions of the lode mining laws are applicable to placers; but the annual ground tax is one yen per 1000 tsubo of surface or per one cho (= 360′) per length of a river bed, except for tin or iron sands, for which no ground rent is required. The royalty to be paid to the government on the gross output is the same, namely, one hundredth of its market value.

With all mining claims, there are certain fees for permits, registration of claims, etc. These laws were in force in Korea in 1910 under Japanese administration. Previous to this time, several concessions had been granted of considerable areas. The American Concession, on which are the mines of the Oriental Consolidated Mining Co. and the Suan Concession, owned by the Collbran & Bostwick Companies, have both proved very valuable. The Italian Concession of Huchang, comprising about 266 square miles of land, contains some valuable contact-metamorphic copper deposits, which have been mined and smelted by the Koreans in the past.

The Chicksan Concessiòn, and the French Concession, in the Chang Song District, are also under lease to foreigners.

The Japanese are so efficient in operating their own mines that there is little incentive for foreign development companies to enter the Japanese sphere of influence in the Far East. Nevertheless, gold mining under English and American auspices has prospered in Korea and it may also be noted that Korea has prospered under Japanese rule.

In Korea, placer gold has been mined for centuries, and more recently, gold, silver, copper and graphite. In 1913, 140,000 tons of iron ore were exported. Korea produced 243,922 fine oz. of gold in 1912.

In eastern Mongolia there are valuable gold and copper deposits. In southern Manchuria there are operating coal mines, and probably valuable copper deposits. In Sakhalin there are important coal and oil deposits. In the islands of Japan proper, gold, silver, copper, iron and coal mines have been operated for centuries, and the production is important.

Production of Japan, Including Formosa and Korea, in 1912.

Gold, fine oz.	456,970
Silver, fine oz.	4,561,085
Copper, metric tons	62,486
Lead, "	3,613
Coal, "	19,515,285
Petroleum, "	222,854

The Chinese Republic.

In recent years, several informing articles have appeared in the Mining Press and in the Trans. A. I. M. E.* on the mineral resources and mining laws and regulations of the new Chinese Republic. From the new Republic, we may exclude Mongolia and Manchuria, as these have in effect been divided between Japan and Russia.

Read states that the mineral wealth is theoretically the property of the central government and is only worked by permission on a royalty basis. Recently a bureau of mines has been created and a mining code adopted, but it does not appear that this code has as yet been approved by the powers, in reference to the rights of foreigners mining in China. Coal, the metals and precious stones are separate from the ownership of the surface. Salt and petroleum are government monopolies. Non-metallic minerals generally go with the land. As in Korea, operations are prohibited near public works generally, and near temples and graves. However, as in Korea, compensation may be made for disturbing graves. Claims are bounded by vertical planes. Coal claims vary in size from 54 to 1180 acres; and claims for other deposits vary between 10 and 540 acres. The ground tax is 45c. per acre per year, and in addition there is the ordinary land tax, paid everywhere in China. On the product of metallic mines, 1½% of the market value is collected as a tax, and for non-metallic minerals, 1%. There are many difficulties in the actual acquiring and operating of mining claims, due to the nature of the mining regulations, and

*"The Mineral Production and Resources of China", T. T. Read, Trans. A. I. M. E., Oct. 1911, vol. XLIII, 1912; Garrison, "Mining Conditions in China", E. & M. J., July 3, 1915; other important articles on the resources by Hoover, Shockley, Weld and others, may be found in the transactions of the A. I. M. E. and of the Inst. of Min. & Met. in London.

perhaps more especially to the ignorance of the higher mining officials of modern mining methods.*

The most valuable deposits at present known in China are those of coal and iron; and if we knew of the results of the prospecting for oil by the Standard Oil Co. during the last year, we might be able to add oil to the category. Gold, silver, quicksilver, tin,† copper, nickel, lead, zinc, arsenic and antimony have all been mined in the Republic with varying degrees of success. The Shui-Kou-Shan mine in Hunan has produced 53,000 tons of galena and 134,000 tons of zinc-blende since 1896; and this property is operated to a certain extent on modern lines by the local Chinese government.

If the invitation, previously noted, extended by Mr. Liang is made good in practice, it is evident that there is a great field for exploration companies in China. Mr. J. Schlenzig, a mining engineer of Shanghai, is skeptical on this point.

Production of China in 1912.

(Mineral Industry)

Gold, fine oz.	160,750
Tin, metric tons	5,800
Iron Ore (Han-Yeh-Ping Iron & Coal Co.), tons	192,800
Coal, metric tons	13,000,000

The products of the other mineral substances are not at hand.

Latin-America.

The greatest new field for United States investments generally is Latin-America.‡ In reply to a letter requesting information about the mining laws of South American republics, the

* "Mining in China", Mining Press, Sept. 18, 1915.

† W. F. Collins, Tin Production in the Province of Yunnan, Trans. Inst. M. & M., London, vol. XIX, 1910.

‡ Consult the publications of the Bureau of American Republics in Washington, and Consular reports; also "Trade Possibilities in Latin-America", Mining Press, Nov. 21, 1914. "Latin-American Monetary Systems and Exchange Conditions", Joseph T. Cosby of the National City Bank of New York, 1915; "Code of Commercial Nomenclature" published by Bureau of American Republics, Washington, April, 1908. This gives the Spanish and Portuguese equivalents of our commercial terms. Lincoln Hutchinson, "The Panama Canal and International Trade Competition", Macmillan Co., 1915.

Pan-American Union of Washington states that "We have on our files the mining laws of most of these countries, but inasmuch as changes are made from time to time, we do not publish any work containing translations of all of them." Nevertheless, I shall attempt to present such information as is available, hoping that the representatives of Latin-American countries and engineers who have visited these countries and who may be present will give further information and correct any errors.

Central America.

The mining laws of the Central American republics are not at hand, but there are a number of gold-quartz mines successfully operating, among which are the following: In Salvador, The Butters Salvador Mines, Ltd., and the Butters Devisadero Co.; in Honduras, the New York & Honduras Rosario Company, and the Socorro Gold and Silver Mine, Ltd.; in Costa Rica, the Abangarez and the Montezuma; in Nicaragua, the Central American Mines, Ltd.

Cuba.

In Cuba,* iron and copper deposits of importance are being mined, and the oil deposits of Trinidad are proving valuable, while the enormous asphalt deposits have long been producing.

Venezuela and the Guianas† will be passed over, not because these regions do not contain valuable mineral deposits, but because of lack of sufficient data. In Venezuela there are important deposits of asphalt and prospecting for oil is now going on there; and in all these countries there are metal mines of importance.

Gold Product in 1912.

(Mineral Industry)

Venezuela, fine oz.	17,682
British Guiana, fine oz.	42,563
Dutch Guiana, fine oz.	13,948
French Guiana, fine oz.	144,675

* Kemp, Bull. 98, 103 and 105, A. I. M. E., 1915.

† J. H. Powell, "Gold Mining in British Guiana", Trans. Inst. M. & M., London, 1900, vol. VIII; A. F. J. Bordeaux, "The Gold-Fields of French Guiana", Trans. A. I. M. E., Nov. 1910, vol. XLI; "Mining Conditions in French Guiana", E. & M. J., vol. 98, p. 509, 1914; "Gold-bear-

Colombia.

The mining laws in general of Colombia are said to be favorable to foreigners, who, themselves, can denounce claims. A lode claim or mineral in place consists of three pertenencias; and a placer claim is 2 by 5 kilometres, the annual tax on placers being $5 per claim. No work on the mining claims is required so long as the taxes are paid. The two main mineral products appear to be gold, which has been mined for centuries, and coal, which has hardly been mined at all. Some articles credit Colombia with a total gold production of about $700,000,000, and other estimates are higher. There are large deposits of coal at Cali, some 200 miles north of Caceres; near Bogota; and in the Sierra Nevada complex on the Rancheria River, near Rio Hache on the Caribbean Coast. At Buena Ventura is a deep and well sheltered harbor right in the track of steamers plying in the South American trade, and making a half-way coaling station between Australia and Europe. It is said that this port will shortly be connected with Cali in the center of the coal measures.

Among rare products, Colombia is noted for its production of platinum and emeralds.

The present prosperity of the Pato and Nechi gold dredging companies suggests that these are merely forerunners of numerous other companies, as the amount of dredgable auriferous gravel is large, and the failure of many of the older companies is said plainly to have been due to mismanagement or lack of sufficient capital. It is also altogether likely that some of the numerous gold-quartz veins will in time be operated at a good profit. Sharpless* refers to the frequent occurrence of smelting ore and of the smelting now going on at the Zancudo mine.

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ing Quartz Veins in Dutch Guiana'', J. B. Percival, E. & M. J., Sept. 25, 1915.

* Mining Press, Sept. 26, 1908. For other information, see Frank Owen, ''The Gold Mines of the Remedios District'', Trans. Inst. M. & M., London, 1895, vol. IV; Garrison, Mining Press, Feb. 6, 1909; F. P. Gamba, Trans. A. I. M. E., Oct. 1911, vol. XLIII, 1912; and many other articles in the Mining Press, Engineering & Mining Journal, etc.

Production of Colombia for 1913.
(Mineral Industry)

Gold, fine oz.	160,750
Silver, fine oz.	835,900
Platinum, fine oz.	15,000

Ecuador.

According to Isschot,† the mining legislation of Ecuador is conceived in a very liberal spirit. An annual tax of 4 pounds sterling on operating mines is payable to the state, and when not operating the tax is reduced to 17 shillings. Mining machinery and supplies are admitted free of duty.

In the province of Esmeraldas, there are, or were, huge hydraulic mines and there are probably dredging deposits available. There are indications of petroleum along the Pacific seaboard, and there are coal deposits of unknown value. Inasmuch as at one time Ecuador produced much gold, it is probable that with sufficient capital, properties could be acquired which would be profitable. The South American Development Company, with United States capital, is operating a gold-quartz mine at Zaruma.

Bolivia.

In Bolivia,‡ any person having legal capacity, whether native or foreign, may prospect for minerals, on merely giving notice to the local authorities of his intention to do so. As many as 30 pertenencias (each 100 metres square) may be contracted for by one person and held in perpetuity so long as the annual taxes of five Bolivianos ($2 in gold) per pertenencia are paid. Mining companies can possess much larger holdings. Machinery and tools for mining are admitted free of duty.

The gold deposits are extensive, but not much worked at present. There are said to be extensive deposits of auriferous

† C. Van Isschot, ''Les Gites Mineraux de l'Equateur'', Ann. des Mines, 1901; see also, W. A. Wolf, ''Sketch of the Geology of Ecuador'', Mining Press, July 27, 1912; J. P. Finlay, ''Notes on the Gold Mines of Zaruma, Ecuador'', Trans. A. I. M. E., vol. XXX, 1900.

‡ See Carlos Sanjines, Mining Press, March 9, 1912; G. W. Wepfer, Mining Press, Feb. 14, 1914; Robert Hawkhurst, Eng. & Min. Journal, Nov. 5, 1910; Howland Bancroft, Trans. A. I. M. E., Aug. 1913; Francis Church Lincoln, Mining Press, 1914 and 1915; Francis Church Lincoln, ''Gold Mining in Bolivia'', E. & M. J., Feb. 20, 1915.

gravels, notably on the Tipuana, Mapiri and Suchez Rivers in the Department of La Paz. In the same region there are numerous gold-quartz veins, some of which are being mined by the Incaoro Mines Company of Delaware.

Copper deposits in sandstone in the Corocoro and Carangas districts are said by Hawkhurst to be important and are being operated to some extent, the annual production being about 4,000,000 lbs.

In silver production, Bolivia ranks second among the South American republics. The mines of Huanchaca are especially valuable. The total production from 1545 to 1825 is given by Wepfer as $3,400,000,000.

At the present time the tin production of Bolivia is its most important mineral asset, amounting in 1911, according to Bancroft, to 23,000 metric tons, and the Bolivian Customs estimate the value of the tin export for 1912 at $23,000,000. Nearly all of this tin comes from lode deposits, which are now the most important tin-lode deposits in the world. Notwithstanding that the United States is the greatest consumer of tin, it is scarcely represented in the tin-mining operations, the most important single interest being that of Simon Patiño, a native Bolivian, whose properties yield one-third of the total production.

Production of Bolivia for 1912.
(Mineral Industry)

Gold, fine oz.	1,117
Silver, fine oz.	3,984,639
Copper, metric tons	4,681
Tin, metric tons	23,027

The export taxes on metals and minerals are high and are graduated according to London prices. When copper is from £60 to £70 per ton in London, the tax is £1-8-4 per ton. When tin is £200 per ton, the duty on concentrates is $34.80 gold per metric ton and for tin bars $122.20 per metric ton.

Peru.*

Reliable information concerning the mining laws of Peru is not at hand. Machinery for mining is theoretically ad-

* Haley and Rodegerdts, "Prospecting Conditions in Peru", Mining Press, Dec. 1913; L. W. Strauss, "Mining in Peru in 1913", Mining Press, March 21, 1914; Firebrace, "San Antonio de Poto Hydraulic Mine", Mining

mitted free of duty, but various engineers claim that this regulation is not always observed by the customs officials.

The important features of Peruvian mineral resources are the copper, silver, petroleum, coal and borax deposits. The copper and silver output comes chiefly from the several smelters in the Cerro de Pasco district including that of Casapalca. The undeveloped borax deposits near Arequipa are now owned by the Borax Consolidated, Ltd., which has a concession, exempting the product from duty for 18 years, commencing from the date when the company begins to export at the rate of 20,000 metric tons of calcined borax per year.

The district of Huancavelica was formerly a great producer of quicksilver, the total product probably exceeding the total product of California to date.

Production of Peru in 1912.

(Mineral Industry)

Gold, fine oz.	23,823
Silver, fine oz.	9,323,500
Copper, metric tons	26,483
Petroleum, metric tons	233,486

There is a prospective export duty on copper, on a sliding scale based on London prices, which would require the payment, with copper at 17 cents per pound, of about $250,000 per year by the Cerro de Pasco Company on an estimated output of 50,000,000 lbs. This company has spent $25,000,000, has built 125 miles of railway, and gives employment to thousands of people. It has thus been a strong factor in the development of Peru and seems entitled to protection rather than taxation.

Chile.*

Mining laws and regulations are liberal in Chile. Deposits of gold, silver, platinum, mercury, copper, lead, zinc, bismuth, cobalt, nickel, tin, antimony, arsenic, iron, chrome iron, manganese, molybdenum, vanadium, radium, iridium, tungsten, and precious stones may be acquired by location, whether on public

Press, Dec. 5, 1908; Sample, ''Mining and Smelting at Cerro de Pasco'', E. & M. J., Jan. 25, 1908; Sample, ''The Cerro de Pasco Mining District'', E. & M. J., Jan. 18, 1908; L. W. Strauss, ''The Casapalca Smelter'', Mining Magazine, July, 1911.

* Juan Blanquier, Mining Press, March 29, 1913.

or private lands. In addition, coal may be acquired by location, when on lands belonging to the state or private municipalities, but not when on private property.

The state has created a monopoly of all deposits of guano which exist in Chile and no trade is carried on in this particular product at present. The same conditions exist as to nitrates found on public lands and lands belonging to municipalities, with the exception that lands containing nitrates may be acquired from the State by purchase at public auction. All alluvial deposits, such as auriferous gravels, may be acquired by location. Any man or unmarried woman of 21 years of age can take up a metallic mineral claim containing an area not to exceed 36 acres, and a non-metallic mineral claim of an area not to exceed 120 acres. No limit is fixed as to the number of claims which may be owned by corporations. Taxes on mining properties are as follows: For those containing metallic deposits, \$0.80 per acre per year;† for non-metallic deposits, \$0.015 per acre per year; for auriferous gravels, \$0.082 per acre per year.

An export tax on the metals based on the London price, similar to that now in effect in Bolivia, but at a lower rate, is said to be proposed, and will be acted on by the next Congress, according to report. This will have the effect of discouraging foreign investments.

Chile is pre-eminent in the production of sodium nitrate; there are also undeveloped potash deposits, and the borax deposits are important; its copper resources are great, as well as the coal deposits. There is also said to be a good future for gold-quartz mining. Of the 170 nitrate treatment plants, only one is controlled by U. S. capital, namely, the Du Pont Powder Company, or its successor.

Production in Chile for 1912.

(Mineral Industry)

Gold, fine oz.	19,290
Silver, fine oz.	868,050
Copper, metric tons	39,204
Coal, long tons	1,321,000
Sodium nitrate, long tons exported	2,478,000
Borax, metric tons	43,356

† The following are only a few of the numerous articles on the mineral resources of Chile: Pope Yeatman, "The Braden Copper Mine", Mining

Brazil.‡

All lands are freehold in Brazil, and it is therefore in the power of the owners of the land to permit mining or not, as they please; the tendency, due to ignorance of the cost and profits of mining, being to ask exorbitant prices.

Mining properties may be acquired in the following ways:

1. By option of purchase at a term and price fixed. This is the arrangement usually adopted by the prospector, exploratory work being done during the life of the option. A penal clause obliges the vendor to give up his property to the buyer, who, in turn, deposits a sum of money with the vendor, to be forfeited in case of non-fulfilment of his covenant.

2. By simply leasing the land for a number of years, with payment of a fixed royalty per ton of ore extracted. Though very common, this method is not recommended, because of the legal difficulty of enforcement. The owner may sell the property without regard to his contract or lease; in that case the lessee can only claim against the proprietor with whom he made the contract, and not against the new proprietor.

3. By leasing the land for a short period with option to purchase. This is a satisfactory way for the prospector to acquire a property, as it enables him to explore it thoroughly; and his only loss, in case he does not exercise his option, is the amount spent on labor and machinery, the latter generally reverting to the owner of the land.

4. By purchase of the mineral rights only. In Brazil, this is not often done, because separate ownership of the soil and

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Press, Dec. 16, 1911; Juan Blanquier, ''The Copper Mines of Chile'', Mining Press, 1913; S. H. Loram, ''Gold District of Canutillo'', Trans. A. I. M. E., Feb. 1904; Walter S. Tower, ''The Nitrate Fields of Chile'', Mining Press, Sept. 27, 1913; L. W. Strauss, ''The Chilean Nitrate Industry'', Mining Press, June, 1914; R. A. F. Penrose, Jr., ''Gold Region of the Straits of Magellan'', Mining Press, Jan. 23, 1909; Severo Salcedo, ''Potash Deposits of Chile'', E. & M. J., Aug. 7, 1915.

‡ ''Laws of Brazil'', H. K. Scott, London Inst. M. & M., Feb. 1902. ''Brazil in 1913'', Butler & Tanner, London. See also Branner, ''Bibliography of the Geology, Mineralogy and Paleontology of Brazil'', Bull. Geol. Soc. of Am., vol. 20; H. K. Scott, ''The Gold-Field of Minas Geraes'', Trans. A. I. M. E., 1902, vol. XXXIII.

the mineral rights is likely to result in much friction and bad feeling.

5. By purchase outright of the freehold. This practice is most generally followed; but it is well to note that there is always a possibility of having the title contested, if the negotiations are hurried through too quickly. Special care must be taken to see that the boundary lines are correctly marked, as this has often been a source of contention. In case of a contest, it is preferable to avoid litigation and come to some compromise.

In general, Brazil is noted for its gold, precious stones, manganese and iron deposits. Perhaps the iron deposits, which are very extensive, form its most important asset in the mineral line. Coal is known, but is of poor quality. Harder* says that the Brazilian iron ore problem has been carefully studied during the last few years by men competent to judge, and the prevailing conclusion has been that the ore can be transported to Europe to be smelted and the products sold at a profit, whereas it would be quite out of the question to attempt the establishment of an extensive iron industry in Brazil. Extensive holdings have been acquired by North Americans and Europeans.

The gold mines are principally developed in the district of Minas Geraes, and are accessible from the Central Railway of Brazil. Some of the mines are important, the Morro Velho, between 1834 and 1884, having produced $26,730,000, according to H. K. Scott. This mine is still producing and is said to have paid about $10,000,000 in dividends to date. It is moreover noteworthy as being the deepest gold mine in the world, the lowest workings being about 7600 ft. in depth from the surface, measured on the dip of the vein. Moreover, although there was much water in the upper workings, the lower levels are said to be dry.

Scott gives the product of the old Gongo Socco between 1826 and 1856 as $8,564,000, and the Passagem between 1884 and 1900 as $4,556,000, the recovery averaging $7.38 per ton. He also mentions nine other gold mines as operating, most of the ore averaging about $8 per ton in gold. The London Times' corres-

* Trans. A. I. M. E. Bull. No. 100, 1915; discussion of paper by E. C. Harder in Bull. No. 94, 1914.

pondent estimates the total gold product of Brazil as $465,000,000. In view of these facts, gold mining in Brazil in the future must be regarded as deserving investigation.

Lead and tin deposits are also known.

Argentina.

This country is not and never will be a great producer of metals, in so far as present developments indicate. The agricultural and live stock resources are, however, very important. At present petroleum is the most valuable mineral product. Wells have been drilled in several states, both by private companies and the government, in some cases with good results.*

In 1914, the average monthly production was over 5000 cubic meters of petroleum from government wells, and Well No. 4 of Commodoro Rivadavia was producing 2400 cubic meters daily in 1913.

In Jujuy Province, there are borax deposits operated by the Compania Internacional de Borax and some gold dredging has been done.†

In Rioja Province, the Famatina mine, an English concern, has produced some copper.

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* Windhausen, ''Geologie der argentinischen. Petroleumlagerstätten'', Petroleum Zeitschrift, Berlin, 1914; Windhausen, ''Reisen in den Territorien Rio Negro und Neuquen'', Neues Jahrbuch, Stuttgart, Beilage Band XXXVIII, 1914; ''Oil in Argentine'', Mining Press, Sept. 9, 1911.

† Jenks, ''Mineral Resources of Jujuy Province, Argentine Republic'', Mining Press, Feb. 20, 1915.

Paper No. 159

THE FINANCING OF MINES IN THE UNITED STATES.

By

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INTRODUCTION.

With the huge mineral production emanating from this country, we naturally assume a most important position in the world of finance. Below is a tabulation showing the production of the important minerals of the United States, also that of North America, with the values thereof. There is also incorporated the percentage which the production of the United States and North America bears to the production of the World.

Mineral Production.*

Mineral	Year	United States		North America	
		Percentage of World Production from U. S.	Approximate Value	Percentage of World Production from N. A.	Approximate Value
Pig iron	1912	41.0%	$ 458,200,000	42.2%	$ 471,600,000
Coal	1913	39.5%	760,500,000	40.5%	779,700,000
Petroleum	1913	65.1%	237,100,000	71.8%	261,500,000
			$1,455,800,000		$1,512,800,000
Lead	1913	34.4%	37,200,000	41.0%	44,300,000
Spelter	1913	32.1%	35,300,000	32.1%	35,300,000
Copper	1913	55.3%	184,700,000	64.5%	215,400,000
Silver	1912	25.6%	37,900,000	71.0%	105,000,000
Gold	1913	19.2%	88,900,000	27.1%	125,600,000
		33.3%	$ 384,000,000	45.2%†	$ 525,600,000
Grand total			$1,839,800,000		$2,038,400,000

* More recent data for world's production not available.

† Percent of world's production.

The World's basic wealth is derived from two sources, mining and agriculture. Mining has been placed before agriculture, because the great era in advanced agricultural development owes its success to the adoption of the metals for improvement in transportation facilities and harvesting. Over half the freight of all the railroads in the United States is furnished today by the mining industry, directly and indirectly. Without metals, the world could not progress. We could not engage in lumbering, agriculture, transmit power or protect ourselves against attack; nor could we convey a message by electricity or transport materials and people by railroads.

While I hardly believe this country will find itself even at the zenith of its mineral output during this generation, still, I believe the greater part of future American increase in annual mineral production will be derived from deposits which are known today. This will come about through greater efficiency with present processes and the development of new ones. The tendency is, naturally, to treat lower grade material, as the richer ores are extracted; with the result that ores are treated today at a large profit which, in some instances, were considered rebellious only ten years ago. Thus, the value and life of many existing mines may be greatly augmented, to say nothing of the increase in earnings which may be realized as these improvements develop.

AMERICAN INTERESTS ABROAD.

While London has long been recognized as the World's money center, there has, since the present war, been a shift of importance to New York, which many believe will result in Americans interesting themselves more freely in foreign enterprises. At the present time, there is an embargo intended to discourage, and in certain directions prevent, the raising of capital from the public abroad for new enterprises. On the Stock Exchanges in Europe, practically all business must still be done on a cash basis. The normal facilities of credit abroad are thus disturbed, and if new enterprises are to progress, the money therefor must be secured in the United States or on onerous terms from private sources in Europe.

It is a noteworthy fact that while there are very consider-

able amounts of American mining securities held abroad, still the financing of practically all American mining operations is effected in the United States. This same applies, though to perhaps a lesser degree, to the mines of Canada, Mexico and Central America. In these latter countries, the English are well represented, and the French rather well in Mexico.

At the present time, money is easy in the United States, and a combination of circumstances promises to have its effect, in that mining enterprises, though located at great distances abroad, will now be considered more seriously by American interests. The result will be that foreign mining securities will probably drift to these shores in volume, where they have thus far been more or less of a curiosity. The eventual development will be the formation of American companies for these properties wherever be their location abroad.

THE AMERICAN ENGINEER.

American engineers have taken the lead the world over, and the development of mineral fields under their supervision has been most efficient and rapid. The American, also, observing the rapidity of ore extraction in his own country, has kept an eye on the distant, known but partially developed, fields abroad; and, applying the varied experience gained in this country, has entered the Russian, Siberian and the Far Eastern fields. Americans have figured in South America for many years and are becoming more potent as time passes, but the advent of the American on the Eastern Hemisphere is of rather more recent occurrence.

It can be safely stated that the present successful operation of some of the principal mines in Russia and Siberia is largely due to Americans: these properties in many instances, prior to the entrance of Yankee talent, were either unproductive or losing ventures.

THE FORTUNES OF MINING.

When the list of Americans of great wealth who are or were engaged in the mining industry is perused, one cannot refrain from concluding that the production of minerals is a profitable and attractive industry. We have on this list and

among us, the Rockefellers, Andrew Carnegie, John D. Ryan, W. A. Clark, Thomas F. Ryan, the Lewisohns, W. R. Hearst, D. C. Jackling, the Guggenheims, Charles Hayden, John Hays Hammond, F. L. Higginson, A. Chester Beatty, E. C. Converse, Charles MacNeill, Cleveland H. Dodge, Eugene Meyer, Jr., E. P. Earle, E. J. Berwind, Galen Stone, James Douglas, William Crocker, R. L. Agassiz, and William B. Thompson.

Among those of prominence who were formerly largely interested in mining are the late H. H. Rogers, James B. Haggin, Marcus Daly, James G. Fair, John W. Mackay, James G. Flood, Thomas F. Walsh, Collis P. Huntington, Leland Stanford, D. O. Mills, Alexander Agassiz, William Earle Dodge, Quincy Shaw, Jacob Langeloth, and Albert F. Holden.

In Europe, we have such notables as the Rothschilds, Wernher, Beit & Co., Eckstein, Joel, Hirsch, H. C. Hoover, Leslie Urquhart, Lord Harris, A. Fell, Newman, Phillips, Viscount Milner, R. W. Schumacher, Sir Lionel Phillips, and Davidoff, and we have not forgotten the names of Cecil Rhodes and Barney Barnato, and Hamilton Smith.

Instances of mines located in the United States which have paid great fortunes in dividends are enumerated below. None are mentioned in this list which have paid less than $5,000,000 in dividends; also, these properties are all operating today.

Copper.

Name of Company.	Location.	Dividend* paid to date.
Arizona Copper	Arizona	$ 19,200,000
Anaconda	Montana	95,400,000
Baltic Mining	Michigan	8,000,000
Boston & Montana	Montana	63,200,000
Calumet & Hecla	Michigan	126,250,000
Calumet & Arizona	Arizona	21,560,000
Nevada Consolidated	Nevada	18,200,000
Kennecott	Alaska	7,500,000
Copper Range Consolidated	Michigan	14,000,000
Quincy	Michigan	21,200,000
Superior & Pittsburg	Arizona	8,900,000
Tamarack	Michigan	9,400,000
Utah Copper	Utah	27,000,000
Utah Consolidated	Utah	8,700,000

* These figures derived from unofficial sources.

Copper.—Continued.

Name of Company.	Location.	Dividend* paid to date.
Chino Copper	New Mexico	$ 5,175,000
Wolverine	Michigan	8,200,000
North Butte	Montana	11,900,000
Old Dominion	Arizona	7,300,000
Osceola	Michigan	12,400,000
Parrot	Montana	7,500,000
United Verde	Arizona	34,800,000
Champion	Michigan	9,500,000
United	Montana	7,100,000
Gold or Silver.		
Alaska Treadwell	Alaska	15,300,000
Goldfields Consolidated	Nevada	28,000,000
Homestake	North Dakota	37,800,000
Stratton's Independence	Colorado	5,000,000
Tonopah Belmont	Nevada	7,200,000
Camp Bird	Colorado	10,300,000
Tonopah Mining	Nevada	12,600,000
Portland	Colorado	9,900,000
Standard Consolidated	California	5,200,000
Lead or Lead-Silver.		
Federal Smelting	Idaho	12,500,000
Bunker Hill & Sullivan	Idaho	16,200,000
Silver King	Utah	13,000,000
Daly West	Utah	6,600,000
Ontario	Utah	15,000,000
St. Joseph	Missouri	9,500,000

Below are given the more important American holding companies whose earnings are derived very largely from mining, but who may also do a smelting and refining business. Certain of these companies own share interests in one or more of the companies tabulated above, and several have large mining interests in Mexico.

	Dividend paid to date.*
Amalgamated Copper Co.	$92,500,000
American Smelting & Refining Co.	80,500,000
American Smelters Securities Co.	24,700,000
International Nickel Company	26,200,000
National Lead Company	38,000,000
Phelps, Dodge & Company	38,200,000
United States Smelting	22,000,000
Guggenheim Exploration Company	22,000,000

* These figures derived from unofficial sources.

PROTECTING THE INVESTOR.

The unscrupulous promoter in mining is not a character so frequently met with as in former days; the enforcement of laws in certain of the States, known as the "Blue Sky" laws has acted as a deterrent. The Federal law, whereby the use of the mails to defraud is heavily punishable, has by its most rigid enforcement been a means of largely eliminating one of the worst types of sharpers. The Post Office officials, through a special department created for the purpose, now keep a keen look-out for illegitimate mining literature. Many famous offenders of recent years have been convicted under the new law, where, even though brought to trial on previous occasions on indictments brought by a state, no great difficulty seemed to have been experienced in evading punishment.

PUBLICITY IN MINING.

The laws of England are in advance of ours in safeguarding the public. There, a full disclosure of all details regarding the properties themselves, the owners and their financial connection with their company, must be made. (The Companies Act of 1876.) The English laws even go so far as to require the vendor to state the extent of his interest in the transaction, so that the outsider, if he has only ordinary business judgment, has sufficient information to determine whether the business is attractive under the financial plan proposed. In the United States, we cannot, unfortunately, demand through the law that all desirable information be produced by corporations. However, publicity is becoming more the rule throughout the country. The more important mining corporations now issue reports concerning their output, the value thereof, profits, etc. Those who do not issue, not alone these periodical reports, but complete annual reports as well, are not looked upon with the same degree of trust, and their securities do not enjoy the same public confidence.

To put in effect the policy existing in England of requiring mining companies to issue full and frequent statements, and to disclose information concerning contracts, the purpose for which stock is issued, etc., would most likely meet with disfavor

in this country. These requirements certainly have not impeded the wheels of progress abroad. As a matter of fact, the field of securities is infinitely larger in England than in America, as anyone will observe by perusing the great number of mining issues on the exchanges abroad and the free market these securities enjoy. The range of price fluctuations of mining securities there seems narrower than in the United States, which is probably accounted for by the fact that stockholders better understand the value of their properties and are slow to part with their investment at a sacrifice in times of depression, for they have facilities for estimating the intrinsic value of their shares.

THE CAUSE OF FAILURES.

In my opinion, the risk in mining is no greater than in other industries where ordinary intelligence is exercised and where technically sound methods are practiced. A large number of the original ore discoveries of the world can be traced to men having little conception of geology, but the eventual commercial success of practically all these enterprises can be attributed to the work of the mining engineer, the metallurgist, and the chemist, with the assistance of the banker.

Failure of most mining enterprises can be traced to the same causes that bring failures in other industries. Persons who do not exercise reasonable intelligence in financial matters lose, no matter what their business. The layman, no doubt, has had bitter experiences in many instances when he has invested in mines; but I believe that the total loss has been greatly exaggerated, because, unfortunately, this loss has fallen largely upon those of moderate means, having no knowledge of mining, who are lured by the prospect of large profits from a small investment, and who are prey for unscrupulous vendors of worthless property.

I would quote, here, from the recent translation by H. C. Hoover of Agricola de re Metallica, published in 1556.

"Some owners prefer to buy shares in mines abounding in metals, rather than to be troubled themselves to search for the veins; these men employ an easier and less uncertain method of

increasing their property. Although their hopes in the shares of one or another mine may be frustrated, the buyer of shares should not abandon the rest of the mines, for all the money expended will be recovered with interest from some other mine. They should not buy only high priced shares in those mines producing metals, nor should they buy too many in neighboring mines where metal has not yet been found, lest, should fortune not respond, they may be exhausted by their losses and have nothing with which they may meet their expenses or buy other shares which may replace their losses. This calamity overtakes those who wish to grow suddenly rich from mines, and instead, they become very much poorer than before. So then, in the buying of shares, as in other matters, there should be a certain limit of expenditure which miners should set themselves, lest blinded by the desire for excessive wealth, they throw all their money away. Moreover, a prudent owner, before he buys shares, ought to go to the mine and carefully examine the na-
his guard lest fraudulent sellers of shares should deceive him.
ture of the vein, for it is very important that he should be on
Investors in shares may perhaps become less wealthy, but they are more certain of some gain than those who mine for metals at their own expense, as they are more cautious in trusting to fortune. Neither ought miners to be altogether distrustful of fortune, as we see some are, who as soon as the shares of any mine begin to go up in value, sell them, on which account they seldom obtain even moderate wealth".

For the layman to purchase a mining property without technical advice, is almost always destined to failure when operating is attempted. It has often been said that "Poor management cannot spoil a good mine", but great exception is taken to this. If the property is extraordinarily rich, money may be made in spite of poor management; but if the maximum profit which one is entitled to receive is not realized, then the enterprise is certainly not a success, from a commercial standpoint. Mismanaged properties usually come to grief.

The logical way to size up a mining proposition before investing therein is to first ascertain the names of those identified with the company and consider this data in the same light that one would in passing judgment on any other business. It is

always important to determine the financial status of the enterprise, and, particularly, the status regarding indebtedness. A recent balance sheet will show this position. It is of no less importance to make a personal study, or have same made by an engineer, of all available engineering data concerning the property, and to be guided accordingly in making an investment.

The dividend record of a mine is by no means a sure way of determining its future, although it may be an aid in determining the value of previous productions. It is well to remember that every ton of ore mined diminishes the asset value of the property just that much, so that too much stress should not be placed on past records of production.

THE IMPORTANCE OF GOOD FINANCING.

The various stages of financing a mining property are interesting to follow. We have to begin with the "prospect", on account of which probably the greatest losses are incurred, because in this stage the risk is greatest. This fact, though generally recognized in the profession, is not sufficiently appreciated by the inexperienced; with the result that payments out of all reason are made for property. The basis on which the initial investment is made very frequently renders eventual profit remote, even though the vein looked for is encountered.

Sight is frequently lost of the additional capital required to develop the mine before ore extraction is possible, and the financial requirement for a plant is usually under-estimated; also, the question of financial requirement for working capital must be figured on, and this item is frequently neglected, which is often the case in all industries. Until output is marketed and paid for, the payroll must be met from capital funds; and, in the case of many metal products, a period which may run into several months elapses from the time the ore is broken down until the metal is refined. The banker will discount your bill of lading covering the shipment of certain unfinished products, but even before this bill of lading can be produced, it will be seen that there is an interval for which working funds must be available.

THE DIFFERENT TYPES OF INVESTORS.

There are various classes of investors: the one class, as I have pointed out, is not so fortunate and he cannot hope for a better fate, for he invests regardless of conditions, in fact, frequently does not even know the location of the mine, the shares of which he purchases. The prospector in the hills is the "original being", and he is the man who deserves undying credit. Through suffering and privation he locates the claims on which he has discovered mineral or presumes it to exist. In this operation, the government is his protector so long as he complies with certain requirements as to the work to be performed. If he develops ore, he holds out as long as his resources last, and sometimes amasses a fortune. He more often than not, however, over-estimates the value of his find, through lack of technical knowledge, and eventually accepts less return for his labor than may have been offered him originally before all the conditions were disclosed.

As development in a new camp progresses, reports drift to the cities, and the critical geologist and mining engineers begin to arrive on the scene. If they report favorably, the next class of investor is attracted from the city. This class is frequently a syndicate of operators; the syndicate either buys out the prospector or takes him in as partner and assists him to hold and further develop his properties, in consideration for an interest therein. If no ore body is disclosed, either the property is dropped or the syndicate sells to some more venturesome interests who believe in the geological conditions and are willing to spend a certain sum in backing up their convictions. If the property develops in a promising manner, the original owner or syndicate usually derives a handsome profit. Once this stage is passed and a certain sure value proven, the larger financial interests enter the field and negotiate for such ownership as they may contemplate acquiring. If the business is not in competent hands, they will install their own organization, and then proceed to develop the property up to the point where the public may, with safety, be invited to participate.

There have been instances where individuals or small groups of individuals have made great successes, apart from

banking connections. I think, however, the largest number of these successes can be traced to two conditions; first, the individuals happen to be persons very strong financially, who, even though they have little knowledge of mining, can afford to employ engineers of high technical skill and integrity; secondly, the deposit happens to be of unusual richness. If the ore is of an easily marketed type and occurs near the surface, very little outside financing may be required. In the Cobalt Camp, for example, rich silver ore is found at or near the surface; and while the shipment of this material in the early days of the camp was very costly, still the grade of the material was so high and the ore so easily mined that financing these properties was an unusually simple procedure. In Cobalt, however, as in all other camps, the eccentricities of the ore deposits were little understood at first, and greatly exaggerated statements of the conditions were made, both by unscrupulous promoters, as well as by well-meaning, but optimistic, mining men.

Almost every new mineral discovery is attended by a rush, and an ensuing boom in property values. History points out that either the situation eventually collapses on account of entirely misdirected efforts, or else the district boils down to the final development of a few important mines and many hundred valueless prospects. This has been the result in Cobalt and in Porcupine, in Ontario, both important discoveries of recent years; likewise in Cripple Creek, Colorado, and Goldfield, Nevada, with the history of which we are all familiar.

INVESTMENTS COMPARED.

There is one point about a good mine, as compared to many other industrial enterprises, which, though obvious, is not given due credit. It is generally known that many securities have a market value, based very largely on earning capacity, rather than on assets. An industrial company may have, say, $6,000,000 of actual liquid assets, and earn, say, $1,500,000 annually. With these conditions, it would not be unusual to find such a company capitalized with $5,000,000 of 7% preferred stock and, say, $15,000,000 of common. After the preferred is provided for, there is left but $1,000,000 of assets for the common stock,

and still the fact, that earnings of $1,150,000 remain (after payment of 7% on preferred) for the common stock, or 7.66%, may be made a basis for establishing a market value of $100 for each of the common shares, when, as pointed out, the $15,000,000 of common stock has only $1,000,000 of assets behind it. Should the intelligent and trained interests in this concern dispose of their holdings and retire from the business, we could well imagine it deteriorating and the earnings greatly diminished.

As compared to the above, let us, for the sake of discussion, take as an example the large copper properties known as the "Porphyries". Before great capital expenditures were made at these properties, large tonnages of ore were proven by elaborate development work. A certain assured life was established before the public was invited into the enterprises. In but few instances have the entire mineralized areas of these properties been prospected, so that in addition to the assured life of this type of property, which may range from 20 to 50 years, there is, in addition, the value which must be placed on possibilities. The value behind these shares, then, is not alone an earning power, but actual assets in the form of ore.

In metal mining, there is no competition in the ordinary sense,—the market is free for all comers. The industry is so large and so widely dispersed that, should the existing management of a property retire, there is a wide field of trained men from which to choose. There are few secrets in the trade on which success may depend. The requirement is conservative banking and technical skill. Fortunately, we are blessed with the presence of many men having each of these qualities, and sometimes both qualities combined.

COAL MINING.

Investments in American coal properties, with few exceptions, present opportunities to realize hardly more than bank interest, and it is, therefore, difficult to attract public interest to them, even though proving the extent of a coal bed in advance is possible with a great degree of accuracy. The large coal properties are usually owned by the railroads, and the

transportation of the commodity has been a source of great profit to the carriers.

The marketing of coal by the operator who is divorced from the railroad has, in the past, frequently presented considerable difficulty. To determine definitely and in advance the quantity of coal which can be disposed of, within a definite range of prices, before a colliery is equipped and operating, is not always a simple matter, and unless long time contracts are made, changes in conditions, due to competition and changes in freight rates, may lead a good property into difficulties. Coal mining presents many uncertainties, from the operating side, in the way of preventing accidents, which are very unfortunate and also very costly. Strangely enough, many of these are apparently not preventable, despite the fact that a high type of equipment may be installed.

In the case of coal, today, the small interests have little field for profitable investment, unless ideal topographical and physical features surround the property. There are cases where a few individuals of moderate means have profited with small operation. This might also be possible today, where, for example, the deposit is on the railroad and the seam is fairly thick and outcrops at the surface, and where the load is down grade to the railroad cars from the heading where the coal is broken.

In general, the coal business is strictly for the strong interests, because relatively large amounts of construction and working capital are required before the properties can be made permanently profitable.

OIL PROPERTIES.

In the case of oil, we have a business requiring great sagacity. The capriciousness of oil deposits is proverbial, and a very large factor must be allowed for the unforeseen. However, a basis for financing an oil property can be evolved which will protect the investor and yield him a splendid return. Assuming the existence of an oil field is established, the important point in financing an oil property, if in a new district, is to await the subsidence of the boom if it is well advanced

and then to finance in such a way as to provide liberal working capital. This provision will make it possible to continuously drill new wells to insure the replacement of the diminishment in production which may occur.

A small oil property where there are, say, two or three wells of modest production, is to my mind an unattractive proposition, where the area and conditions do not lend to expansion of the business. There are many ways of making money in the oil production business, but, above all, the price paid for the land must be conservative.

The oil business is becoming more a counterpart of coal, as time passes, for it is found that largeness of operations is the safer course. It is also becoming more potent that to combine production, transportation, and refining in one corporation is by far the safer method of embarking in the oil business.

If the oil is heavy and the wells are deep, the production business is essentially difficult. The field expense of drilling 3000-ft. wells, in California, for example, may easily range from \$20,000 to \$40,000, and require six to eight months' time; and the production therefrom, on a steady basis, may be difficult to maintain. There are many uncertainties in store for the oil producer, and only he that anticipates them will be successful. From an investment standpoint, the production of light oil from shallow wells appears to me the safer, because the wells, being shallow, are easier to replace on exhaustion; also, the product being of the lighter variety, is more easily marketed. Instances may be cited of deep wells producing a heavy product having realized a very large profit for the investor; but unless the production per well is comparatively large and steady, I would not be attracted too readily to the deep-well proposition. In any case, I would be inclined towards the property that has independent means to provide transportation and refining facilities. Gushers are fine to anticipate, and in certain cases have resulted in huge profits. I believe, however, that the producer usually prefers a dependable supply from steadily flowing wells, for gushers frequently become uncontrollable and often waste themselves, doing considerable damage to neighboring lands and streams, thus leading to legal difficulties.

MINING SECURITIES AS INVESTMENTS.

To finance a manifestly safe proposition, even though vouched for by estimable parties, has up to recent years been no easy matter. I believe, however, that a material change has taken place and that more confidence is being inspired in the public mind since it has been demonstrated that mining can be conducted on safe lines. This change has developed to such an extent that I am prone to say that it is a greater task today to find a good mine than it is to finance it. This development has come about through the education of the public, and we have in the United States, today, many of the most highly respected and conservative financial interests acting as bankers for mining enterprises. Where formerly this type was entirely lacking, today the circle is continually enlarging, and this is giving a great impetus to the industry.

THE ISSUE OF SECURITIES.

In financing mining enterprises, no unusual features have been adopted, as compared to the financing of other industries. Some noticeable features, perhaps, are the frequent use of the convertible bond and the infrequent issue of preferred shares. Mining companies are, in nearly all cases, initiated with one class of stock, to supply sufficient capital for the acquirement of the property, and, usually, to at least cover the cost of a development campaign which, it is hoped, will establish the value of the property beyond peradventure. When this stage is arrived at, it is, in normal times, an easy matter to finance further—assuming, of course, that the value of the proposition has been accredited by engineers recognized in the banking fraternity to be competent. The second stage may be the issue of additional shares ranking *pari passu* with those originally issued, but the price of issue may be higher, in view of the improved chance for successful eventualities. As the mine develops and a positive value is created, the convertible bond is well adapted, and this form of security has become very popular in mining. The success of convertible bonds in mining finance dates, to my recollection, to the inception of the porphyry copper companies, and in nearly all cases have been

favorably received by the public. These bonds are usually issued at par, but their convertible point depends, of course, on the state of advancement of the business at the time the bonds are issued, and with which state the shares, under normal market conditions, will fluctuate in synchronism.

Some companies prefer to issue sufficient bonds at one time to supply all anticipated future needs, the size of plant being definitely decided upon. Frequently, however, the plan adopted is to provide sufficient new capital to reach a certain stage of operation, even though this may not be the final capacity planned. Especially may this be the case if financial conditions promise better things for the future than accrue at the time of issue. In this case, convertible bonds of the same series, or possibly convertible debentures, may be issued at a later date, with the advantage of a higher conversion price and the consequent necessity of setting aside a fewer number of shares to provide for the conversion. When financing is done long in advance of all requirements, the plan of paying for bonds in long installment periods has been adopted; in some instances, these periods may cover a year or more.

The advantage of the convertible bond lies in the fact that not alone is it safer than the stock and also gives the investor a return on his investment pending the payment of dividends on the shares, but, simultaneously, he may derive a profit through the conversion privilege in case the price of the shares advances beyond the point of equality. When the bond is converted, the interest charge automatically ceases to be fixed.

It is hardly necessary to discuss the variations in convertible securities as applied to mining, in so far as bonds and debentures or convertible preferred shares are concerned. The latter form of shares, as previously stated, is seldom met with in mining in the American markets; though where a reorganization of a company is involved, preferred shares have been adopted. The provisions covering these issues are quite similar to the type ordinarily met with in the financing of enterprises other than mining.

The sinking fund in the case of bonds bears a most important position in mining finance, for it must be remembered

that mineral deposits are always depleting themselves; and while the life of a mine or oil property may promise long duration, the time of exhaustion is sooner or later certain to arrive.

A sinking fund, therefore, should be provided, which should be sufficient to retire the bonded indebtedness. The usual method is to set aside a certain sum per ton of ore mined, which it is calculated will retire the debt. The date when this charge, which should be a charge against operations, takes effect is calculated to become operative when it is estimated that normal extraction operations will commence.

SUMMARY.

In the foregoing, an effort has been made to more thoroughly diffuse the fact that mining is a major industry without which the world could not progress, and that the risk involved is no greater than in other industries where average intelligence is exercised and technically sound methods practiced.

We have read how the investor of today is protected, and how the growing spirit of publicity has afforded him a means of keeping in touch with the operations at the properties of which he is a stockholder, and of how this policy has advanced the industry by inspiring the public with confidence.

The investor in mines has two alternatives—either to purchase title to the property for his own account, or else to purchase shares of a company having assets consisting of mining property. In any case, engineering advice is the first essential to the layman; for without it, the chance of profit is remote. In the case of purchasing a mine, the most searching investigation of all features pertaining to the property is a prime requirement. This information should be sought out by a conservative and reputable engineer,—one who is competent to pass upon the particular kind of property under consideration. After determining the ore occurrence, the next most important features to be studied are the questions of transportation facilities and the availability of power and water.

The layman, in studying the engineer's report, can draw his own conclusions. He need not be an engineer to decide for himself whether the estimates of time to arrive at a certain

stage of operation and the cost estimates are conservative, and whether due allowance has been made for unforeseen contingencies. Other similar completed propositions give him a good idea of what may be expected, so that if the report which has been rendered appeals to him, he can then embark on the enterprise with every degree of confidence as to ultimate results; always assuming, as has been particularly referred to, that the venture is properly financed.

Where parties, as Agricola said, "prefer to buy shares in mines abounding in metals, rather than to be troubled themselves to search for the veins", we have to deal with that large class who fail to profit by their investments on account of their speculative tendencies. Facilities exist for careful investigation of mining properties, and where investment is intended, the same caution should be observed as in buying the property itself. Primarily, the investor should only interest himself in those enterprises where the means are supplied to follow the progress of work, the operating results, and the financial status of the business.

Paper No. 160

EUROPEAN MINING FINANCE.

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INTRODUCTORY.

Considerable progress has been made during the last few decades in connection with the formation of companies to develop mining properties, and London, the world's chief money centre, has assisted in no small degree the attainment of that progress. The other European money centres have, of course, contributed also, but not nearly to the same extent as London. Here, as elsewhere, the promotion of mining propositions has for the present been checked by the great European War now in progress, and maybe some considerable time will elapse before anything like the former activity is witnessed again. There are the important facts to be remembered, however, that the war is dispersing huge quantities of the products of the mining industry; that when peace reigns once more mineral products will be needed in great quantities in connection with the reestablishment of other industries; and that although the supply of capital for purely speculative enterprises will not be so great as before, legitimate schemes having for their object the opening up of fresh mineral resources are hardly likely to be left without support.

EUROPE AND THE WORLD'S MINERAL PRODUCTION.

Before proceeding to deal with the requirements and methods of British promoters of mining companies, it may be of interest if I illustrate the very important part European countries and their foreign possessions play in connection with

the mineral production of the world. Quite complete and up-to-date statistical data relating to the output of the various parts of the world are not available, but information is given in a portion of the report recently issued[1] by the British Home Office which enables one to gain an idea of the position. For instance, in the report mentioned, there is a table of statistics which shows the number of persons engaged in mining and quarrying at home and abroad. This compilation is incomplete, inasmuch as no figures are published by several countries, viz, Bolivia, Brazil, China, Persia and Turkey, so that the total of nearly 6½ millions in the table probably falls considerably short of the real aggregate. However, the figure is instructive, especially when one analyses the returns and discovers that European countries and their foreign connections represent just over five millions, or 77 per cent of the total. Turning then to the statistics relating to the annual production of the most important minerals, we find that nearly 63 per cent of the world's output of gold is contributed by European countries and their colonial possessions, and that of this 63 per cent the British Empire is alone responsible for almost the whole. More than half the total number of mining employees being engaged on coal mines, the output of that mineral naturally ranks first —a long way first—as regards quantity; and here also we find European influence strong. Although America produces more coal than the United Kingdom, the latter, together with other European countries and their possessions abroad, figure for rather more than 60 per cent of the aggregate for the whole world. They also contribute over half the iron. On the other hand, America has the "pull" as regards petroleum, and also produces more than half the world's output of silver and copper.

While rough calculations such as these are interesting, they do not, of course, fully illustrate the scope of the subject of European mining finance, which is, in fact, as wide as the geographical distribution of the world's mineral resources. Political boundaries do not greatly concern mining financiers, who are, as a rule, ready to seize upon a likely thing in any country, literally "from China to Peru". The promotion of

[1] January 1915.

mining enterprises is, in fact, largely a matter of opportunity coupled with financial resources and more or less technical knowledge.

THE PROMOTION OF MINING COMPANIES.

Conditions change from time to time in the world of mining finance, just as they do in other spheres of activity. One year, perhaps, sees an increase in the number of gold mining companies formed, another year copper rules the roost, or, maybe, alluvial tin schemes predominate. To a large extent the class of mining companies promoted is determined by the swing of the pendulum on the London Stock Exchange, where, by the way, sentiment always plays a part. Mining financiers of standing, being in a position to abide their time, are usually prepared to consider schemes and take over the good ones, whether they happen to coincide with the Stock Exchange fashion of the moment or not; whereas the smaller fry, with limited, and possibly very attenuated, financial resources, can hardly afford to do so. The latter, however, generally manage to get hold of something when a Stock Exchange boom is on, and this accounts for the flotation of ''prospects'', which, in the absence of great speculative excitement, would stand little chance of attracting public money.

In London the promotion of mining companies of any size is undertaken, as a rule, by one or other of the numerous exploration or prospecting syndicates, or companies, which have been formed specially to deal with business of this kind. Mere ''prospects'' are not run after. A developed mine, having some ore actually in sight and a satisfactory outlook, stands probably the best chance of being taken up. It is true that many of the now well-known mining companies operating on the famous Witwatersrand gold-field were formed and provided with working capital before the sinking of a shaft on their ground had even been commenced, but that field has always been regarded as unique in having a comparatively regular reef formation. Apart from this, mining promotions were more readily made on slender data in those days than they are now, except, perhaps, in boom times. Another type of proposition likely to be given careful consideration by mining financiers of standing

in London—who, by the way, include some well-known citizens of the United States—is the mine, which, after being worked in the somewhat distant past, was abandoned for metallurgical reasons or because metal prices fell to too low a level to permit of the property being profitably exploited any longer. Evidence must be provided, however, that it was not left because the lode pinched out at depth, and it must not be a very deep water-logged mine. In the case of a property whose workings extend only a short distance beyond the oxidised zone and where the nature of the formation lends itself to the testing of the sulphide zone by means of bore-holes, and the old records indicate that the former workers gave up on account of their being unable to treat the sulphide ore, then the presence of water in the old workings would not be regarded as a great drawback; and, providing satisfactory terms could be arranged, the proposition would, in all probability, be taken up with a view to the formation of a company.

Many mines are taken up, in the first instance, under option. Of these, the proportion that comes eventually before the mining public is probably not very great. Many are optioned, but few are called. In this connection, the interesting case may be cited of a mining finance company whose shares rose to a high price on the London Stock Exchange last year, solely on the strength of the fact that it appeared to have secured a piece of business having great potentialities. Before that business was secured, however, the management had investigated and turned down between four and five hundred other propositions!

What has become of the rejected, someone will wonder. Well, they will probably be, if they have not been already, offered elsewhere, and very likely some of them will eventually appear before the mining public; for when a Stock Exchange boom is in progress, as previously mentioned, properties find a market much more easily than in normal times. It does not necessarily follow that all the rejected were worthless. Some, no doubt, had considerable merit, but the vendors probably opened their mouths too wide, and the fact of their having been turned away may have done good by modifying their ideas of values.

The question of price is one of the great difficulties in connection with the placing of mining properties. Vendors usually

think that their geese are swans, and are, consequently, apt to regard the people who are considering the question of financing the mines as nothing better than thieves and robbers. No doubt this attitude accounts for many a promising mine being turned down—at any rate, temporarily.

THE FINANCING OF MINES.

Having secured the offer of what appears to be a promising mining proposition and arranged for a working option, the exploration or finance company with which the financiers are associated will start work thereon, and if at the end of the option period the results are satisfactory, the option will be exercised and the mine taken over. Probably the vendors will have stipulated for a share interest in any new company that may be formed to acquire and work the mine, in addition to a cash payment. Market conditions being propitious, a new company probably will be formed. Sufficient working capital may be guaranteed by the parent exploration company and its associates themselves taking up shares at par, in which case it may be thought unnecessary to incur the expense of making an appeal to the public by means of a prospectus. Instead of issuing a prospectus, it may be decided to have the shares introduced on the Stock Exchange through the medium of a firm of brokers. (The prospectus and non-prospectus methods will receive further consideration in a subsequent portion of these notes.) In the event of an offer of shares to the public being decided upon, there will be underwriting arrangements to fix up, and these will probably be made with friendly mining groups and Stock Exchange firms. Underwriting commissions are not always payable in cash. Sometimes they take the form of an option for a period on a portion, or on the whole, of the unissued shares at par, or some other fixed price. A good clue to the quality of the proposition whose shares are offered to the public is often afforded by the size and nature of the commission payable to the underwriters.

As regards the capitalisation of mining ventures, there is no definite rule as to size. But there is a rather common failing, namely, that however large the nominal capital of a company may be, it more often happens that the working capital is inade-

quate than the reverse. Too often the size of the capital is determined, not by the immediate and prospective requirements of the mine, but by the rapacity of the vendors and the promoters, who are guided to some extent by their judgment of the capacity of the public at the time. Of course there should be some relation between the size of the mine, its ore reserves, its possibilities of extension, its financial requirements, and the amount of capital the public is asked to provide in order to pay the vendors and to furnish resources for the working of the property. But hard and fast rules cannot be laid down which would meet the requirements of all, or even a fair proportion of mining-finance schemes. No two mines are exactly alike, nor have any two groups of mining financiers exactly the same ideas.

Several companies in recent times have followed the lead of a number of the South African gold mining concerns and have raised large sums of money on debentures. In some cases, these debentures carry conversion rights, that is to say, they can be exchanged for shares in certain fixed proportions. This gives the holder of debentures a chance of securing some return in addition to the fixed rate of interest, and if the company is successful it stands to get its debenture debt reduced automatically by the conversion rights being exercised. In a recent case, debentures were offered for subscription, carrying, in addition to conversion rights, an option on shares at par for a fairly lengthy period. If these options are exercised, the company will, of course, receive a further supply of capital.

The debenture method of raising money has an advantage over that of issuing cumulative or participating preference shares. Dividends on shares can be paid only out of profits, and the earning of profits usually means the attainment of a fairly advanced stage of operations. Debenture interest, however, can be paid out of capital, pending the attainment of the productive and profit-earning stage. Of course, it is not every mining concern that can justifiably raise money on debentures; and this method, like many others, is liable to be abused. One or two cases have come under my notice where the so-called debenture bonds offered for subscription were really no better than ordinary shares; the high rate of interest they carried should have been enough to warn off the public.

LIMITED LIABILITY COMPANIES.

The financing of undertakings by means of companies is, by the way, almost as old as the hills. Mr. H. C. Hoover, in one of his many instructive notes to the translation of Agricola's "De Re Metallica", mentions that the ancient Greeks formed companies to work the silver mines of Laurion, and that company organisation was very common among the Romans, who speculated largely in the shares. From these ancient methods of conducting operations on cooperative lines have been developed the methods in present-day use, apparently the chief modification being the adoption of the principle of limited liability. Even now, this principle is not universally adopted throughout the British Empire; but it is probably safe to say that nearly the whole of the British capital invested in mines at home and abroad is represented by shares in companies having the word "limited" at the end of their titles, though some of them may be private and not public limited companies. Other European countries have their own mining companies formed on a similar principle, and large interests are also held there in undertakings which have been registered either in Great Britain or in British colonies under the limited liability system.

"Limited liability" means, of course, that the holder of a share is not legally liable for calls amounting to more than the face, or nominal, value of that share. In the event of more capital being required, when all the company's shares are issued and are fully paid up, some scheme may be devised for "raising the wind"—a reconstruction involving a fresh assessment being the common plan—but the holder of a fully-paid share can refuse to assume any further liability. In that event, he is entitled to have his interest in the concern bought out, but in practice this rarely means that he gets anything worth having. At the same time, the holder of a partly-paid share remains legally liable, so long as he holds that share, for the amount of the outstanding calls, and even forfeiture of the share does not release him from this liability.

MINING AND THE STOCK EXCHANGE.

Mining for tin, copper, lead and blende had been carried on in Great Britain for centuries; the huge deposits of coal and iron had attracted large amounts of capital; and millions had

been found for the exploitation of gold mines in South Africa, America and Australia; but previous to the great South African boom of 1895 the mining section of the London Stock Exchange was a small and unimportant affair. Many brokers, as well as people outside the Stock Exchange, looked askance at anyone who talked of dealing in mining shares, which was regarded as gambling and a vice, and it was not until the year mentioned that public interest in mining ventures became widespread. A remarkable change then came over the scene. Continental as well as British investors poured enormous orders into London for South African shares, and ever since that memorable time the investment of money in mining enterprises has assumed a different aspect—at any rate, amongst the British public.

Statistics published by the Mining Journal of London, relating to the incorporation of new mining companies, show that in the ten years, 1893-1902 inclusive, the number of companies registered in London was 5482, and their aggregate capitalisation was £582,915,449. Of these, 950 companies, capitalised at £56,234,626, were for operating in Great Britain, and were for the most part connected with iron and coal mining. The other 4532 companies, with a total capitalisation of £526,680,823, were formed to carry on operations abroad. In the year 1895 close upon 150 companies, with a capitalisation of about 18¼ millions (£18,250,000), were formed in England in connection with the South African gold mining industry; while in 1895 and 1896 some 700 companies were registered in London, with a capital aggregating £72,000,000, in connection with the gold mining industry of Western Australia. The comparatively small number relating to the Transvaal is explained by the fact that the majority of companies which were formed to exploit the "banket" beds of the Witwatersrand gold-field were registered in the Transvaal, not in London. The mining claims there, after being taken up by local syndicates or by finance companies like the Consolidated Gold Fields of South Africa, Limited, were floated off and the shares of the separate companies were placed on the market, usually at a substantial premium. Several of the mines at Kalgoorlie, Western Australia, were originally floated in Adelaide, but later British companies acquired the interests of the Colonial concerns.

No doubt there are still some people who regard dealing in mining shares as a form of vice, while probably some of those who indulge in speculative purchases would frankly admit, if asked, that to them it is merely a form of gambling. But the old prejudice has worn down under the pressure of a growth of knowledge respecting mining matters. In has come to be more generally realised that the mining industry has played an important part in connection with the civilisation and material progress of the world, a part it is still destined to play; and one of the chief requisites of the mining industry, of course, is capital. I have heard it deplored that mining and speculative activity in shares should be so linked up together. Idealists have gone further and have contended that the mining industry should be entirely disassociated from the Stock Exchange. How then would the requisite large sums of capital be found? Eliminate the chance of making profits by dealing in shares, and probably only a very small proportion of what may be termed the mining public would be ready to embark its capital in mining ventures. Few of those who provide capital for the opening up of mines do so with the intention of simply holding on to their shares until they die or until the company they are interested in ceases to exist. Human nature being what it is, and the millenium being still in prospect, mines and share-speculation will probably continue in association; and it seems to me that the best thing to do in the circumstances is to try to educate the mining public, so that it will be able to discriminate between good, fair, poor, and absolutely worthless propositions.

MINING PROSPECTUSES AND THE PUBLIC.

One outcome of the growth of public interest in mining shares during the last twenty years is that mining prospectuses are, as a rule, more carefully compiled nowadays. In the so-called "good old days" more was thought of presenting an attractive "front page" than of providing essential data as to the mine. By an attractive front page was meant an imposing list of directors, and an imposing list of directors meant a number of titled individuals. Such things as "ore reserves" and "profit in sight" were hardly thought of then. Now, more information is expected about the mine whose shares are offered for subscription, and a

company is not cold-shouldered because the directorate does not include a Duke, a Marquis, a Lord, or a Baronet. The appearance on a board of directors of one or more well-known mining engineers is much more important, and if, in addition to such a directorate, there is a technical committee, composed of mining and metallurgical experts, so much the better. Then as regards the inside of a prospectus, a report of the property, solely by the vendor's engineer, is not sufficient. An independent engineer's report should be forthcoming, and, assuming that the mine is already opened up to a certain extent, he should provide an estimate of the quantity and average value of the ore fully and partially developed. It will then be possible for the potential purchaser of shares to form an idea of the reasonableness, or otherwise, of the consideration payable to the vendors. If it is an alluvial venture, an estimate should be provided of the available yardage and its metal contents; the latter based on the results of the bores or pits, the number of which should be stated.

Fine phrases which really mean nothing are, unfortunately, not always left out of modern mining prospectuses; while every now and then one comes across a document containing extravagant statements printed in large type, which the promoters no doubt fondly hope will make up for the absence of convincing data. A fair number of the public, however, now know at least a few of the tricks of the trade, having learnt a little by experience—costly experience, it is to be feared, in many cases. But there are many, apparently, who are unable to profit by experience, and so long as a gullible class of people remains in existence the promoters of dubious and downright shady schemes will ply their trade with more or less success. As the saying goes, "you can fool all the public some of the time, but you can't fool all the public all the time". It is those who can be fooled more than once who help to keep a market boom going.

The credulity of a portion of the mining public is really amazing. It is curious how able men of business seem to lose their business acumen once they get outside their own particular line. I have heard of numerous cases of men in responsible positions in the world of finance and industry who have lost money over mining propositions they ought never to have touched. A glowing report on an alleged mine in a remote part of the world,

written by a man they never heard of before, but brought before their notice by a plausible individual able to conjure up visions of easily-gained riches, will often charm money out of the pockets of ordinarily cautious and capable business men. A fine assay result seems to be especially efficacious in such cases. In their haste they overlook the obvious fact that one specimen does not make a mine. It is also curious that once bitten does not make them twice shy. If a market deal goes against them, they will very likely "average" their shareholding in the concern, regardless of a change for the worse in the condition of the mine; while in the event of their being badly treated by the directors, who, perhaps, have withheld material information, they will probably not kick up a fuss, for the reason that they do not want to advertise the fact that they have been foolish. Unfortunately, people like these help to sustain the very promoters and directors the world of mining finance could do best without.

PROSPECTUSLESS COMPANIES.

Many companies which are really dependent upon public support for the provision of working capital do not issue prospectuses. Their shares are "introduced" on the London Stock Exchange, generally at a premium, and by means of advertisements in the papers public attention is called to them, though no shares are directly offered for subscription. This method has advantages from the promoter's point of view. For one thing, and it is not the least important, this method enables the promoter to dodge the Companies Act. British Company Law requires a prospectus to set forth certain essential details, such as the terms of the underwriting of the issue, the consideration payable to the vendors, the participation of any intermediary vendor, the minimum subscription on which the directors will proceed to allotment, and the personal interest in the promoting or underwriting syndicate of each of the directors. Moreover, the directors are jointly and severally liable for the accuracy of the whole contents of the prospectus. The memorandum of Articles of Association of the Company must also be printed on the document. By getting his company's shares "introduced" on the market—through a firm of brokers to whom blocks of shares are optioned at rising prices—the promoter avoids the

necessity of making such disclosures. Usually, printed slips giving brief particulars of the enterprise are circulated in the market, but these slips are unsigned and apparently no one can be held legally responsible for their contents. One would think that members of the Stock Exchange would, in their own interests, make full inquiries into any scheme they are asked to "father", but evidently they do not invariably do so, or they are easily satisfied.

Of course, in the case of companies whose shares have not, for some good reason, come to the London market until the undertakings have been in existence for some time, the non-publication of a prospectus assumes a different aspect. The shares of a well-known American mine, for instance, might not be dealt in in London until a British financial group thought fit to acquire a block of the stock and make the "introduction" on their own account. In such a case, however, records of the company's operations would no doubt be available, and a summary of these would appear on the printed slips issued in market circles "for information only". Records of actual performances are a very different thing to the matter one frequently finds on the slips.

MINING FINANCE IN OTHER EUROPEAN CENTRES.

Although France, Germany and Russia each has its own mining industry, and citizens of the two former countries have interested themselves in mining abroad, the promotion of mining companies in those parts of Europe has not attained nearly the same stage of activity as in Great Britain. Germany is one of the oldest mining countries on the earth, but in that country the mines are mostly run by the State to employ men and to keep other industries going. There is, I understand, a tax on mining scrip in Germany (a tax based on the face value of the scrip), the imposition of which was regarded, at the time, as a piece of grandmotherly legislation to restrict speculation. But it has not prevented German investors from interesting themselves largely in the shares of South African gold mining companies. With the object of avoiding payment of the tax, a good deal of the mining scrip belonging to Germans, mostly in the form of bearer shares—a form uncommon in Great Britain and her Colonies, where registered shares are usually held—has been deposited with firms and individuals in London.

The French, although they have not shown as much enterprise as they might in working the mineral deposits of their own country, have engaged to some extent in mining abroad—in Russia and in South Africa, for instance. But it is not an easy matter to get a mine financed, directly, in France, where only a small *élite* really knows much about this class of business. There are banks and a few firms in Paris which will, through the medium of one of their subsidiary corporations, consider the acquisition of mining properties; but one who should know informs me that high-class financiers there still look askance at mining ventures. Although considerable numbers of South African shares have been placed amongst investors in France, there is not at present a really large public for mining shares in that country. The French law is strict as regards prospectuses, and this direct method of applying to the public for subscriptions is generally avoided. The method usually adopted is much the same as that employed in London when shares are placed without a prospectus being issued. In Paris, the introduction of shares costs a substantial sum of money; in many cases the expense has been considered prohibitive. In the first place, a sum of money has to be deposited with the French "Fisc" authorities, who retain a percentage in respect of every share dealt in; then the firm which makes the introduction of the shares on the Coulisse, the unofficial market, takes a big fee and options on shares; and the provincial brokers who are employed are given shares, at a discount, to dispose of amongst their clients, on the understanding that if any of the shares they sell come back to the market within, say, three months, they lose their commission on the sale of such shares. It is impossible to place any shares on a large scale amongst the public in France without a market quotation being obtained for the shares; and from this follows the expenditure of money amongst the newspapers.

The Russians are not credited with much mining knowledge, but it is said that they will follow a good lead and buy mining shares. "Ore reserves" and "profit in sight" are unfamiliar terms to them, and they will call a "mine", what is merely a "prospect". A number of Russian mining propositions have been financed in Great Britain during the last five or ten years, and the probability is that more will be done in this direction in the

not distant future. It is usual, though the method has not been invariably adopted, for a British-formed company to hold the bulk of the shares of a Russian-formed company, the former being the holding and the latter the operating company. This method is considered to have several advantages. Anyway, it is necessary to have a Russian manager at the mine. When it comes to negotiating with the Government and dealing with labour questions, the fact of there being influential Russians on the board of a local company should certainly prove advantageous; while from the share-dealing point of view there is the fact that the dual arrangement means two markets, one in Petrograd and one in London. The technical control of the mining and metallurgical operations, however, is not left to Russians. This is usually in the hands of engineers in London, who make periodical visits to the properties. The option method of financing mines has been taught the Russians by the British; but the latter might adopt, probably with advantage, in many cases, one of the provisions of the Russian Company Law which requires the founders of a company to subscribe not less than one-tenth of the shares, in the case of a million roubles capital or less, and when the capital exceeds a million roubles, one-twentieth of the shares over and above that number.

THE FUTURE OF MINING FINANCE.

The more actively the world is searched for mineral deposits, the smaller becomes the chance of promising new propositions being located; and the prospect of those who every now and then cry out for a new mining field having their request granted is rendered gradually still more remote. But it may easily happen that before the fresh fields and pastures new are located, mining financiers will find some of the fields already known to them affording fresh scope for their activity. In this connection two points come to mind at once. In the first place, the famous Witwatersrand gold-field is not yet fully developed. Mr. R. N. Kotze, Government Mining Engineer, Union of South Africa, in course of the evidence he gave before the Dominions Royal Commission, in April, 1914, said that the quantity of payable ore in the undeveloped areas of the Witwatersrand was equal, in all probability, to the quantity remaining in the producing mines. (His estimate

under the latter heading was 587,000,000 tons.) And he estimated the capital requirements at, roughly, £50,000,000. Then there are the great mineral resources of Russia. In these, British capitalists have already interested themselves, more particularly during the last few years, and they are looking forward to the time when they will be able to take a more active part in connection with the development of the Russian mining industry, which, according to people well acquainted with that country, is likely, after the War, to assume a much more prominent position than it has attained up to the present. So far as the early future is concerned, the prospects of activity in the world of mining finance are not bright, on account, of course, of the European War. But there is still plenty of scope for the mining financier, and when peace reigns once more he will find business to his hand.

Some of the more recent developments which have been noted in connection with mining finance and company organisation in London encourage a feeling of optimism in regard to the future. Evidence is forthcoming that in some quarters directorates are now being more carefully selected, and that better technical control at headquarters is being provided. These factors must result in improved technical management of the mines. The more widely improvements such as these are adopted, the smaller will become the danger of "scandals", which do harm to the mining industry by checking the supply of public money for legitimate schemes, and the more difficult it will become for the purveyor of "wildcats" or "fakes" successfully to ply his nefarious trade.

BIBLIOGRAPHY.

"Deep-Level Mines of the Rand", G. A. Denny.
"The Gold Mines of the World", J. H. Curle (3d Edition, 1905).
"Principles of Mining", Herbert C. Hoover.
"Mines and Minerals of the British Empire", Ralph Stokes.
Mining Manual and Year Book (Annual).
Mines of Africa.
Bainbridge on Mines and Minerals (Laws of Mining in Britain).
"Mining Law of the British Empire", C. J. Alford.
Rules and Regulations of the London Stock Exchange.
"The Law Relating to (British) Company Promoters", Hibbert and Rafferty.
"The Directors' Handbook", Pixley.
"Company Management" (Formation and Management of Companies under the Companies' Consolidation Act, 1908), Emery.
Palmer's "Company Law".
Russian Year Book (Annual).

Paper No. 161

THE ORGANIZATION OF MINING COMPANIES.

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INTRODUCTION.*

The oldest mining of which we have recorded knowledge is that of the Egyptians, in what is now known as the Sudan, and dates back to 5000 B. C. The mines were worked by slaves, to whom no mercy was shown.

The extensive mining carried on by the Romans was, in part at least, thru proprietary companies; Pliny mentions a company that had a monopoly of the quicksilver mines of Spain and Justinian refers to gold mining and silver mining companies. Company organization was very common among the Romans and speculation in shares was rife. The most popular companies were those that farmed the taxes of the provinces, leased public lands, or took civil and military contracts.†

Loose organizations of workmen are common in many lands and are the precursors of the more formal company organiza-

* This paper was intended to consist of a collection of articles describing the actual organization of a number of our leading mines; 127 engineers were invited to contribute: to this invitation 6 engineers responded. We regret that we have not more descriptions of actual working mines. To those engineers who have sent us information we extend our heartfelt thanks.

† Georgius Agricola de re metallica, Translated by H. C. Hoover and Lou Henry Hoover.

Dictionary of Political Economy, Macmillan.

tions. Some of the coal mines of Shansi, China, opened by shafts up to 300 ft. deep, are operated by combinations of workmen, where all seem on an equality. The Russian workmen also unite in a gang (artel) which operates as a unit. In California the gangs of Chinese who work many alluvial and a few quartz mines seem less formally bound together than are the shareholders in an ordinary mining company.

Their organization is more in the nature of a coöperative and semi-benevolent society. We are told that these societies, or "tongs", have their representatives in China as well as here, and that before the Chinese Exclusion Act went into effect recruits for the different societies were secured by agents in China. The society paid traveling expenses to America. Upon arrival here they were housed and fed by the society and, when possible, jobs were secured for them. When no jobs were available, they were put to work on some of the placers owned or leased by the society. Whatever money was earned or gold recovered was turned into the Company, and the Company in turn furnished the necessary supplies. Just what the ultimate adjustment was is uncertain, but it would appear that those having repaid the society for all previous advances of money and supplies, with liberal interest allowances to the company, would then be considered full-fledged members and participate in any profits accruing to the organization from that time on.

The working out of this arrangement was well exemplified some years ago on a placer property on the American River. We were sent to California to examine this property with a view of mining it by means of a dredge. We found about 20 Chinese at work, all belonging to one "tong". They had a lease on it, which would not expire for some time, so during most of the time of our examination these Chinese were working a portion of the ground.

At first they were wary and would give us no information as to what they were getting, but later on through their "tong", from whom we hired 20 or 30 workmen, we became very friendly, and were given, so we believe, a full and accurate account of the production of these 20 miners for a period of about 8 months. The average product per man per day was about 22 cents, and the average value of supplies furnished

these men during this period was about 12 cents. The company therefore on that transaction made about 10 cents per day per man. If outside work had been plentiful these men would have taken the better pay, only coming back to the mining when more profitable work was not available. The companies used these placers to take care of the surplus labor, and by this means were able to carry the peak load in prosperous seasons without loss during dull times.

We have tried to learn something of coöperative mines, of which a number exist in the United States, but our inquiries have not been answered. That such mines do exist is indicated by litigation that was started against the Granger Cooperative Coal Company, at Winkle, Illinois.

MEDIEVAL COMPANY ORGANIZATION.

Mining-company organization was apparently well developed by the Romans and it must have continued through the Dark Ages, for we find an elaborate description in Agricola. After describing the ownership of the various tunnel and surface rights in great detail, he states:

"I will now speak about the division of ownership in mines and tunnels. One owner is allowed to possess and to work one, two, three, or more whole meers, or similarly one or more separate tunnels, provided he conforms to the decrees of the laws relating to metals, and to the orders of the *Bergmeister*. And because he alone provides the expenditure of money on the mines, if they yield metal he alone obtains the product from them. But when large and frequent expenditures are necessary in mining, he to whom the *Bergmeister* first gave the right often admits others to share with him, and they join with him in forming a company, and they each lay out a part of the expense and share with him the profit or loss of the mine. But the title of the mines or tunnels remains undivided, although for the purpose of dividing the expense and profit it may be said each mine or tunnel is divided into parts.

"This division is made in various ways. A mine, and the same thing must be understood with regard to a tunnel, may be divided into two halves, that is into two similar portions, by which method two owners spend an equal amount on it and

draw an equal profit from it, for each possesses one half. Sometimes it is divided into four shares, by which compact four persons can be owners, so that each possesses one-fourth, or also two persons can be owners, so that one possesses three-fourths, and the other only one-fourth; or three owners, so that the first has two-fourths, and the second and third one-fourth each. Sometimes it is divided into eight shares, by which plan there may be eight owners, so that each is possessor of one-eighth; sometimes there are two owners, so that one has five-sixths together with one twenty-fourth, and the other one-eighth; or there may be three owners in which one has three-quarters and the second and third each one-eighth; or it may be divided so that one owner has seven-twelfths, together with one twenty-fourth, a second owner has one-quarter, and a third owner has one-eighth; or so that the first has one-half, the second one-third and one twenty-fourth, and the third one-eighth; or so that the first has one-half, as before, and the second and third each one-quarter; or so that the first and second each have one third and one twenty-fourth and the third one-quarter; and in the same way the divisions may be adjusted in all the other proportions. The different ways of dividing the shares originate from the different proportions of ownership. Sometimes a mine is divided into sixteen parts, each of which is a twenty-fourth and a forty-eighth; or it may be divided into thirty-two parts, each of which is a forty-eighth; and half a seventy-second and a two hundred and eighty-eighth; or into sixty-four parts of which each share is one seventy-second and one five hundred and seventy-sixth; or finally, into one hundred and twenty-eight parts, any one of which is half a seventy-second and half of one five hundred and seventy-sixth.

''Now an iron mine either remains undivided or is divided into two, four, or occasionally more shares, which depends on the excellence of the veins. But a lead, bismuth, or tin mine, and likewise one of copper or even quicksilver, is also divided into eight shares, or into sixteen or thirty-two, and less commonly into sixty-four. The number of the divisions of the silver mines at Freiberg in Meissen did not formerly progress beyond this; but within the memory of our fathers, miners have divided a silver mine, and similarly the tunnel at Schneeberg; first

of all into one hundred and twenty-eight shares, of which one hundred and twenty-six are the property of private owners in the mines or tunnels, one belongs to the State and one to the Church; while in Joachimsthal only one hundred and twenty-two shares of the mines or tunnels are the property of private owners, four are proprietary shares, and the State and Church each have one in the same way. To these there has lately been added in some places one share for the most needy of the population, which makes one hundred and twenty-nine shares. It is only the private owners of mines who pay contributions. A proprietary holder, though he holds as many as four shares such as I have described, does not pay contributions, but gratuitously supplies the owners of the mines with sufficient wood from his forests for timbering, machinery, buildings, and smelting; nor do those belonging to the State, Church, and the poor pay contributions, but the proceeds are used to build or repair public works and sacred buildings, and to support the most needy with the profits which they draw from the mines. Furthermore, in our State, the one hundred and twenty-eighth share has begun to be divided into two, four, or eight parts, or even into three, six, twelve, or smaller parts. This is done when one mine is created out of two, for then the owner who formerly possessed one-half becomes owner of one-fourth; he who possessed one-fourth, of one-eighth; he who possessed one-third, of one-sixth; he who possessed one-sixth, of one-twelfth. Since our countrymen call a mine a *symposium*, that is, a drinking bout, we are accustomed to call the money which the owners subscribe a *symbolum*,* or a contribution. For, just as those who go to a banquet (*symposium*) give contributions (*symbola*), so those who purpose making large profits from mining are accustomed to contribute toward the expenditure. However, the manager of the mine assesses the contributions of the owners annually, or for the most part quarterly, and as often he renders an account of receipts and expenses. At Freiberg in Meissen the old practice was for the manager to exact a contribution from the owners every week, and every week to distribute among them

* A symposium is a banquet, and a symbola is a contribution of money to a banquet. This sentence is probably a play on the German zeche, mine, this being also a term for a drinking bout.

the profits of the mines, but this practice during almost the last fifteen years has been so far changed that contribution and distribution are made four times each year. Large or small contributions are imposed according to the number of workmen which the mine or tunnel requires; as a result, those who possess many shares provide many contributions. Four times a year the owners contribute to the cost, and four times during the year profits of the mines are distributed among them; these are sometimes large, sometimes small, according as there is more or less gold or silver or other metal dug out. Indeed, from the St. George mine in Schneeberg the miners extracted so much silver in a quarter of a year that silver cakes, which were worth 1100 Rhenish guldens, were distributed to each one hundred and twenty-eighth share. From the Annaberg mine which is known as the Himmelich Hoz, they had a dole of eight hundred thaler; from a mine in Joachimsthal which is named the Sternen, three hundred thaler; from the head mine at Abertham, which is called St. Lorentz, two hundred and twenty-five thaler.‡ The more shares of which any individual is owner, the more profits he takes.

"I will now explain how the owners may lose or obtain the right over a mine, or a tunnel, or a share. Formerly, if anyone was able to prove by witnesses that the owners had failed to send miners for three continuous shifts,* the *Bergmeister* deprived them of their right over the mine, and gave the right over it to the informer, if he desired it. But although miners preserve this custom today, still mining-share owners who have paid their contributions do not lose their right over their mines against their will. Formerly, if water which had not been drawn off from the higher shaft of some mine percolated through a vein or stringer into the shaft of another mine and

‡ The Rhenish gulden was about 6.9 shillings, or $1.66. Silver was worth about this amount per Troy ounce at this period, so that roughly, silver of a value of 1100 gulden would be about 1100 Troy ounces. The Saxon thaler was worth about 4.64 shillings or about $1.11. The thaler, therefore, represented about 0.65 Troy ounces of silver, so that 300 thalers were about 195 Troy ounces, and 225 thalers about 146 Troy ounces.

* *Opera continens.* The Glossary gives *shicht,*—the origin of the English "shift".

impeded their work, then the owners of the mine which suffered the damage went to the *Bergmeister* and complained of the loss, and he sent to the shafts two Jurors. If they found that matters were as claimed, the right over the mine which caused the injury was given to the owners who suffered the injury. But this custom in certain places has been changed, for the *Bergmeister*, if he finds this condition of things proved in the case of two shafts, orders the owners of the shaft which causes the injury to contribute part of the expense to the owners of the shaft which receives the injury; if they fail to do so he then deprives them of their right over their mine; on the other hand, if the owners send men to the workings to dig and draw off the water from the shafts, they keep their right over their mine. Formerly owners used to obtain a right over any tunnel, firstly, if in its bottom they made drains and cleansed them of mud and sand so that the water might flow out without any hindrance, and restored those drains which had been damaged; secondly, if they provided shafts or openings to supply the miners with air, and restored those which had fallen in; and finally, if three miners were employed continuously in driving the tunnel. But the principal reason for losing the title to a tunnel was that for a period of eight days no miner was employed upon it; therefore, when anyone was able to prove by witnesses that the owners of a tunnel had not done these things, he brought his accusation before the *Bergmeister*, who, after going out from the town to the tunnel and inspecting the drains and the ventilating machines and everything else, and finding the charge to be true, placed the witness under oath, and asked him: "Whose tunnel is this at the present time?" The witness would reply: "The King's" or "The Prince's". Thereupon the *Bergmeister* gave the right over the tunnel to the first applicant. This was the severe rule under which the owners at one time lost their rights over a tunnel; but its severity is now considerably mitigated, for the owners do not now forthwith lose their right over a tunnel through not having cleaned out the drains and restored the shafts or ventilation holes which have suffered damage; but the *Bergmeister* orders the tunnel manager to do it, and if he does not obey, the authorities fine the tunnel. Also it is sufficient for one miner to

be engaged in driving the tunnel. Moreover, if the owner of a tunnel sets boundaries at a fixed spot in the rocks and stops driving the tunnel, he may obtain a right over it so far as he has gone, provided the drains are cleaned out and ventilation holes are kept in repair. But any other owner is allowed to start from the established mark and drive the tunnel further, if he pays the former owners of the tunnel as much money every three months as the *Bergmeister* decides ought to be paid.

"There remain for discussion, the shares in the mines and tunnels. Formerly if anybody conveyed these shares to anyone else and the latter had once paid his contribution, the seller was bound to stand by his bargain, and this custom today has the force of law. But if the seller denied that the contribution had been paid, while the buyer of the shares declared that he could prove by witnesses that he had paid his contribution to the other proprietors, and a case arose for trial, then the evidence of the other proprietors carried more weight than the oath of the seller. Today the buyer of the shares proves that he has paid his contribution by a document which the mine or tunnel manager always gives each one; if the buyer has contributed no money there is no obligation on the seller to keep his bargain. Formerly, as I have said above, the proprietors used to contribute money weekly, but now contributions are paid four times each year. Today, if for the space of a month anyone does not take proceedings against the seller of the shares for the contribution, the right of taking proceedings is lost. But when the Clerk has already entered on the register the shares which had been conveyed or bought, none of the owners loses his right over the share unless the money is not contributed which the manager of the mine or tunnel has demanded from the owner or his agent. Formerly, if on the application of the manager the owner or his agent did not pay, the matter was referred to the *Bergmeister*, who ordered the owner or his agent to make his contribution; then if he failed to contribute for three successive weeks, the *Bergmeister* gave the right to his shares to the first applicant. Today this custom is unchanged, for if owners fail for the space of a month to pay the contributions which the manager of the mine has imposed on them,

on a stated day their names are proclaimed aloud and struck off the list of owners, in the presence of the *Bergmeister*, the Jurors, the Mining Clerk, and the Share Clerk, and each of such shares is entered on the proscribed list. If, however, on the third, or at latest the fourth day, they pay their contributions to the manager of the mine or tunnel, and pay the money which is due from them to the Share Clerk, he removes their shares from the proscribed list. They are not thereupon restored to their former position unless the other owners consent; in which respect the custom now in use differs from the old practice, for today if the owners of shares constituting anything over half the mine consent to the restoration of those who have been proscribed, the others are obliged to consent whether they wish to or not. Formerly, unless such restoration had been sanctioned by the approval of the owners of one hundred shares, those who had been proscribed were not restored to their former position.

"The procedure in suits relating to shares was formerly as follows: he who instituted a suit and took legal proceedings against another in respect of the shares, used to make a formal charge against the accused possessor before the *Bergmeister*. This was done either at his house or in some public place or at the mines, once each day for three days if the shares belonged to an old mine, and three times in eight days if they belonged to a headmeer. But if he could not find the possessor of the shares in these places, it was valid and effectual to make the accusation against him at the house of the *Bergmeister*. When, however, he made the charge for the third time, he used to bring with him a notary, whom the *Bergmeister* would interrogate: "Have I earned the fee?" and who would respond: "You have earned it"; thereupon the *Bergmeister* would give the right over the shares to him who made the accusation, and the accuser in turn would pay down the customary fee to the *Bergmeister*. After these proceedings, if the man whom the *Bergmeister* had deprived of his shares dwelt in the city, one of the proprietors of the mine or of the headmine was sent to him to acquaint him with the facts, but if he dwelt elsewhere proclamation was made in some public place, or at the mine, openly and in a loud voice in the hearing of numbers of miners. Now-

adays a date is defined for the one who is answerable for the debt of shares or money, and information is given the accused by an official if he is near at hand, or if he is absent, a letter is sent him; nor is the right over his shares taken from anyone for the space of one and a half months. So much for these matters.''

The system of operating mines described above is very similar, if not identical with the ''cost book'' method by which the ''adventurers'' work the Cornish mines; the similarity is not remarkable, for it is probable that the German miners who came to England in 1561 are responsible for the organization of the mines as well as for the introduction of better mining and metallurgical methods. It may be, however, that this ''cost book'' system originated in England, for Cornwall lays claim to having taught tin mining and metallurgy to the Germans thru a Cornishman who fled to Germany because of a murder, and discovered tin there in 1241. Whether this story is true or not, the ''cost book'' system is the forerunner of the assessments that have supported the mines of the Comstock lode for more than thirty years.

ACQUIRING OF MINES.

Before passing to the organization of modern companies it seems desirable to describe how mines are acquired. The wandering prospector is responsible for the beginning of most mines and the geologist for a very few. As regards the geologist, the celebrated prediction of Murchison that gold would be found in Australia because of its geologic similarity to the Urals, and the actual discovery of gold in that country by Hargreaves, who sought it because of the resemblance of the rocks to those of California, are the chief instances that we remember of geologic discovery on a large scale.

Mines, in the first instances, are often developed by the prospector himself, usually by open cuts and shallow shafts that can be carried on by one man. Shafts have been sunk to a hundred feet or so by one man's labor, but the work is slow and dangerous and the adit more adapted for the solitary worker. Such adits have been run to incredible lengths by patient men who work for a lifetime in the hope of finding a

rich deposit. Pathetic indeed is the fate of some of the 49'ers who struggled alone in their long tunnels for many decades. We remember several whom we saw in El Dorado and Placer Counties in the 80's. Strangely enough they all seemed contented, and even happy. Long years of reflection had given them a philosophical turn of mind and they worked bravely on to the last. Some of the great fortunes of California were won by these solitary miners.

With favorable development the prospector soon requires assistance, and informal partnerships are often formed by which mines are developed to such an extent that they are sold for large sums. The buyers are generally companies, nevertheless a few individuals work mines on a large scale; some of these single-handed operators are pre-eminently successful—few of them are mining engineers.

As a rule, however, the prospector and his friends are unable to put a mine on a dividend basis and this is the work of combined capital. In spite of all that has been said in regard to the reluctance of capitalists to engage in mining, it is a fact that there are a large number of engineers in the United States whose sole business it is to search for new mines. These scouting engineers are employed either by individuals, small groups of capitalists, or by companies. A number of companies have been formed for the sole purpose of finding mines that warrant the investment of capital. Such search for mines doubtless began in prehistoric times, but was not important until the 50's. The successful California pioneers sent men all over the world as prospectors and scouts and many new districts were opened by these searchers. Among recent instances of fortunate "scouting" was the acquiring of the Calumet and Arizona copper mines by a group of merchants and miners living in the "copper country" of Michigan.

In former years mining companies usually confined their operations to one mining district and when their mines were exhausted, they liquidated and went out of business. Latterly, the large dividend-payers devote a portion of their profits to the search for other mines in any portion of the world that seems attractive. Such companies are particularly well fitted to develop new properties, to which they bring an experienced

board of directors and an efficient engineering staff. Many companies are pursuing this course of hunting for new mines, for example: the Tonopah Mining Company of Nevada, the Tonopah Belmont Development Company, the Central Mining and Investment Corporation, Ltd., of London; the Goldfield Consolidated of South Africa; the Guggenheim Exploration Co. The Exploration Company, Ltd., of London is one of the oldest and most favorably known. To a person not familiar with the business of mining, it seems a very simple matter to find a mine that justifies investment of capital. But in reality, the man who has abundant engineering knowledge and capital at his command often has great difficulty in finding a mine that will adequately reward his capital and skill.

The difficulty that the capitalist has in selecting a mine does not arise from a scarcity of offers, for it is safe to say that in any of the great financial centers thousands of properties are on offer continually. Of these thousands, at least ninety percent have no possibility of success and are at once rejected by an experienced engineer. The search for properties is disheartening. We know of an exploration and development company that had 1400 properties offered to it in two years and refused all of them. The exploration department of the United States Smelting, Refining & Mining Company gives the following as the result of its search for mines:

Year	A	B	C	D
1910	684	124	44	2
1911	921	144	28	1
1912	694	121	36	4
	2299	389	108	7

Column A gives the number of mines that were offered to the company, column B the number deemed worthy of a preliminary examination, column C the number of which detailed examinations were made; D gives the number of purchases. The Canadian Mining and Exploration Co., formed in 1912, with a capital of $5,000,000, of which $2,500,000 was paid up, after investigating about 1500 mines, without finding one that was considered worthy of development, gave up looking for mines in 1915 and proposes to return the money to its subscribers. The

total number of offers to the three companies mentioned above is 5199 and the seven mines bought show one purchase to 743 offers.

Notwithstanding these dismal statistics, good mines are still found and vast fortunes made. And it is exactly these great fortunes, these vast rewards, that make it so difficult to buy a mine for a fair price. The prospector is more willing to take chances than is the capitalist and, hence, in order to cover the speculative value of his property, asks a price many times that of the visible profits.

It is often the rash plunger and not the conservative engineer who makes a fortune. Perhaps a concrete instance of how mines are actually acquired may be illuminating. The story was told to me by a wealthy Californian whose plunging in mining had cost him $250,000 up to the time I met him; in spite of these losses he left a very large estate. At the time the incident happened he was a large shareholder in a mine at Tuscarora, Nevada, and was visiting the property to look after his venture. Passing through the assay office one morning he noticed some large silver buttons on the cupels; "Where did they come from?" he asked the assayer. "Oh! Tom Johnes brought them in from a prospect that he has over on the hill about three miles from here. He's been working there about a week." "Smith" (as we will call the capitalist) jumped on his horse and rode over to the prospect. There he found a hole perhaps five feet deep by seven or eight feet long with a vein of rich silver ore; a prospect which a liberally inclined mining engineer might advise his principal to pay $5000 for, and then nearly die of heart disease on thinking over his rashness. "Smith", however, was a plunger and bought the property on the spot for a large sum and then bought out other prospectors who had conflicting claims. In all he paid out $85,000 before he got out of the hole. His faith was richly recompensed, for the mine became one of the largest dividend-payers in that rich camp. The antithesis of this story might be related of many skilled engineers who have "turned down" valuable mines for lack of imagination or faith; e. g., the Tonopah deposit was examined by several engineers who failed to buy, altho the price asked was sticking out of the ground in a large outcrop.

SMALL MINING COMPANIES.

Leaving out of question individual and cooperative ownership, we pass to the consideration of the small mining company. Naturally, no hard and fast boundary can be drawn, but, in order to make the matter definite, we take the case of companies employing a maximum of one or two hundred men with or without a reduction plant. Such a mining company, if operating in the West, is usually organized under the laws of one of the Western States. As a rule the capital is a million dollars, divided into a million shares, par value of a dollar. The shares may be assessable or non-assessable.

A company of this class will have a board of five to seven directors, with president, vice-president, and secretary. The home office is usually in a city where meetings are held monthly or oftener, each share has one vote, and, as a rule, there is but one sort of share. The directors in these small companies usually receive no fees; a small salary is paid to the president or vice-president who actively manages the affairs of the company; the secretary is also a salaried officer and very likely acts for a number of companies.

The work at the mine is carried on by a general manager, who may have a mine superintendent under him and a superintendent of the reduction plant. In many cases the mine manager and the reduction-plant manager are independent of each other and each reports directly to the home office; this is frequently the case in the large copper companies. This arrangement is apt to lead to friction and it is far preferable to have one man in charge of all the operations connected with the mining and beneficiation of the ore. The mine work is carried on by the superintendent, who has under him a foreman who, theoretically, hires and discharges all the employes; practically, the blacksmith, head carpenter and hoisting engineers are selected by the superintendent. Below the foreman comes the shift boss. The surveying work may be carried on by the superintendent in isolated mines or by contract with a local engineer. The positions of clerk and assayer are frequently combined. A gold or silver mill is run on much the same lines as the mine. Under the mill superintendent is a foreman, but, owing to the

small force in a mill, there is not likely to be any night foreman or shift boss. The assayer can keep the books.

In a small mine employing 50 miners and having a dry-crushing silver-mill with 15 employees all told, the management consisted of: a general manager, who also acted as accountant and mine surveyor; an ordinary workman, who was taught assaying, averaged 500 assays per month, and took care of a pair of horses. The mining work was done under the charge of a foreman and a night-shift boss. A mill superintendent kept the mill accounts and acted as assayer. Although a mine of this class could not afford to employ a large administrative staff, yet it seems probable that better results would have been obtained in the above case by the employment of an accountant and storekeeper and a scientifically educated assayer, with an assistant sampler in the mine. A much more accurate record could have been kept of the ore and a saving would have been made in many directions.

RAISING OF CAPITAL. SHARES.

Before dealing with the organization of large mining companies employing, say, a thousand or more men, it seems worth while to give an account of how capital is raised for mining operations. In the beginning of developing a mine, the small amount of money needed is generally found locally; often a number of working miners will club together and furnish a few thousand dollars for development work, as is now being done at Oatman, Arizona. This work is generally carried on through the medium of a company organized for the purpose. The organization of such a company costs not over $100, and the officers serve without cost. But the raising of the capital for a larger enterprise is a much more serious business and requires much interviewing of capitalists and, hence, the person who does this work expects to be paid for it. This person is, of course, the promoter. When we reflect that for writing a few letters and making a number of calls on capitalists, he receives sums running into the hundreds of thousands of dollars—$900,000 in one case, or more than a thousand hard-working coal miners earn by a year's work—it does seem as if the promoter's share is out of proportion to what he does. Nevertheless, modern

business cannot be carried on without the promoter, tho possibly his services may be dispensed with in the future.

The large amounts of capital that are raised for mining in London generally come through a public offering of shares by means of a prospectus, in which the most prominent place is occupied by the names of directors and chairman. In the "boom" times, much capital is raised in the United States by similar means; and the newspapers, which when the boom has died away are the first to condemn fraudulent mining, are filled with flamboyant advertisements. Thru such newspaper campaigns in 1905-1907, the public was fleeced of scores, or hundreds of millions of dollars. In quieter times, much of the capital for mines is found privately and no public offering is made. After a company is fully organized, and the mines are working, the public is induced to buy the shares thru brokers who deal in them on the New York Curb, or in the smaller exchanges of such cities as San Francisco, Salt Lake and Denver.

After a mining company begins operations it is often found that additional capital is needed. The simplest method for providing for this contingency is to make the original shares assessable. From 1900 to, say, 1907, when there was a mining boom in the Pacific Coast States, largely owing to the phenomenal development of Tonopah and Goldfield, nearly all of the hundreds of newly formed companies had non-assessable shares; the argument in favor of these shares was that the buyer was certain what the shares would cost him and would not be subject to further demand. Any money needed for the development of the property was to be provided by the sale of treasury stock which had been held in reserve for the purpose. In the outcome it was found that the treasury stock was generally insufficient to furnish the funds needed and within the last few years (1915) many of these companies have been reorganized and the stock made assessable. Whether the shares are assessable or non-assessable, the capital is nominally the same, no matter what may be the actual cost value of the property. The market price of the shares, however, bears some relation to the actual value of the property. The shares of the less valuable mines sell for as low as a cent, which makes the total value of the company $10,000. Sometimes these shares advance to $20, or a total of

$20,000,000, but this latter figure is not often exceeded of late years; nor is a minimum quotation less than a cent a share often met with. There are many difficulties in this method of financing: one is that under the laws of several of our States the shares of a company cannot be sold unless the company owns property of equivalent value to that of the shares. That is, if in the initial stages a mining company capitalized at one million dollars in a million shares, of a par value of one dollar each, owned property rightly valued at but five thousand dollars, it could not sell any shares until the books of the company showed the property was worth a million dollars. The ledger account for capital must show a credit for the amount of the capital stock balanced by a debit for property, each of a million dollars, although in reality the property is actually worth but five thousand dollars.

Every one who is well informed in mining-company organization understands this procedure and there is no real dishonesty involved; still some conscientious mining secretaries find the certification of this over-valuation very disagreeable. Moreover, the assessors are apt to ask unpleasant questions that require much explanation. For these reasons, some companies are now issuing shares without par value, and this course is advised by the Railroad Commission of California. The most notable instance of no-value shares is that of the Kennecott Copper Corporation; these shares are now selling on the New York Curb for $54 (November, 1915). In this method of finance the share shows that the holder owns an undivided interest in the property of the company, and nothing is said about its value. This is in fact a reversion to the financing described by Agricola.

Another method of financing mines is to issue bonds for the amount of the profit "in sight" and to let the common shares represent the speculative value of the property. These bonds are generally convertible into common shares at a fixed ratio. Preferred shares are also employed for the same end. The bonds seem to be regarded with favor by the general public, but a suggestion that the funds of one of the most important mining engineering societies should be invested in such bonds was derisively rejected. As it turned out such

investment would have been wise. Much could be written on the question of financing, which has its romances as well as its complications, but the above data give the broad outlines of the subject. An interesting variation of the ownership of mines is afforded by the early history of the Comstock Lode,* where the original mines were sold in ''feet'' by mining claim brokers and the ''feet'' were transferred by legal conveyance.

Another matter that must be carefully considered is the scale on which mining operations should be conducted and the amount of capital to be employed. Very profitable mines have been worked by one man, with practically no capital, as in the gold placers, and the ''seam diggings'' of California. On the other hand, the Brakpan mine of the East Rand, in South Africa, expended $5,960,000 before any ore was milled.†

In the realm of pure mathematics the exact amount of capital needed for any given mine is easily determined, for, assuming that we know the rate of interest demanded on the investment, the rate on the sinking fund, the amount and value of the ore, cost of plant, value of plant when ore is worked out, profit per ton for various rates of working and other necessary data, the problem is simply: What amount of capital will return the maximum profit? This problem is easily solved by ordinary mathematics, but in actual mining the problem is vastly more complicated; for, in the first place, hardly any of the required data can be accurately determined until the mine is exhausted. Moreover, except in the case of gold, the value of the ore is conditioned on the market price of the metal that it contains, and the working of a mine on a very large scale might easily break the price. Those who are interested in this question will find it fully discussed in ''The Economics of Mining'', by T. A. Rickard, and ''Principles of Mining'', by H. C. Hoover.

SYMPOSIUM.

Having outlined in the foregoing the principal features of the organization of a small mining company, we will now give

* ''Comstock Mining and Miners'', by Eliot Lord.

† ''Mining Conditions on the Witwatersrand'', W. L. Honnold, Bulletin Am. Inst. Min. Engr., August, 1915, p. 1605.

the statements that we have received from the engineers to whom we sent a circular letter that contained the following topics and questions, about which we asked for information:

1. Capital stock of company.
2. Under what state organized.
3. Powers and duties of president, or chairman.
4. Powers and duties of vice-president, or directors.
5. Powers and duties of secretary.
6. Powers and duties of general manager, superintendent or other officer controlling physical operation of properties; transportation; purchasing of supplies.
7. Description of method of disposing of products.
8. Description of sociological departments, such as safety first, welfare work, workmen's compensation, education, religion, political activities.
9. Dealing with organizations of employes; labor unions.
10. Handling of strikes; employment of mine guards through detective agencies.
11. System for dealing with hints from employes.
12. System for interchange of opinions between various officials and departments. Are formal conferences held and recorded in detail?
13. Is a detailed, or other annual budget prepared for the coming year?

    Note: In Russian mines the preparation of an estimate for the coming year is laborious and for large companies the result is a volume of several hundred pages of minute detail.

14. Are any mines in the United States, with an annual output of say $50,000 or over, run on a co-operative basis?
15. Who controls the company: one man; a small group; another corporation; a general body of shareholders?
16. Should every company have a mining engineer on its Board of Directors?
17. What is the method of employing men?
18. How do you acquire new mines?
19. Geological staff; surveying staff.
20. Litigation department.
21. In view of the fact that mining, on the whole, is a speculative business, would it not be better to have the shares of mining companies represent a proportional interest without any nominal value? That is, instead of having a stock certificate represent 1,000 shares of a par value of $1,000 in a $1,000,000 company, would it not be better to have the

certificate state that it represents a 1/1000 undivided interest? This is practically the system under which the Cornish mines were operated and has been lately advocated by the Railroad Commission of California as a means of avoiding certain legal difficulties of operating a mine not yet fully opened. Discussion of this point would be interesting.

22. In addition to the written statement, we should like a diagram of organization showing the relationship of all officers and employes to each other and to the different departments. It should indicate plainly what officer is responsible for each operation and to whom he in turn is to report and from whom he is to take orders. A diagram of this kind will give the desired information in concise form and may be commented on or explained to any extent desired. If necessary, no mention will be made of its provenance, thereby maintaining an anonymous character.
23. List of books or articles dealing with above subjects with or without comments will be gratefully received.

OUTLINE OF A STAFF ORGANIZATION.*

The outline herewith covers the staff organization of a corporation owning and operating mines, smelters, and manufacturing establishments in various parts of the United States and in foreign countries. In large part its business is competitive, but it also controls certain products of which it has a natural monopoly. The company has had a long and honorable career and the plan of organization is the outgrowth of many years' experience in the particular field occupied. The corporation has been remarkably successful and commands ample capital. As its securities are not in the open market, it prefers to remain anonymous in this discussion. This is a matter I regret, as it would be a pleasure to give credit directly to the men who have devised and are operating one of the best organizations of which I know.

It will be noted that the affairs of the company fall into two groups, each under immediate charge of a vice-president (Fig. 1). The 1st vice-president deals with all business that relates to legal matters, accounts and audits. It will be noted that the business is audited and a close financial check maintained by a staff not concerned with plans or performances,

* H. Foster Bain. Editor Mining Magazine, Salisbury House, London, E. C., England.

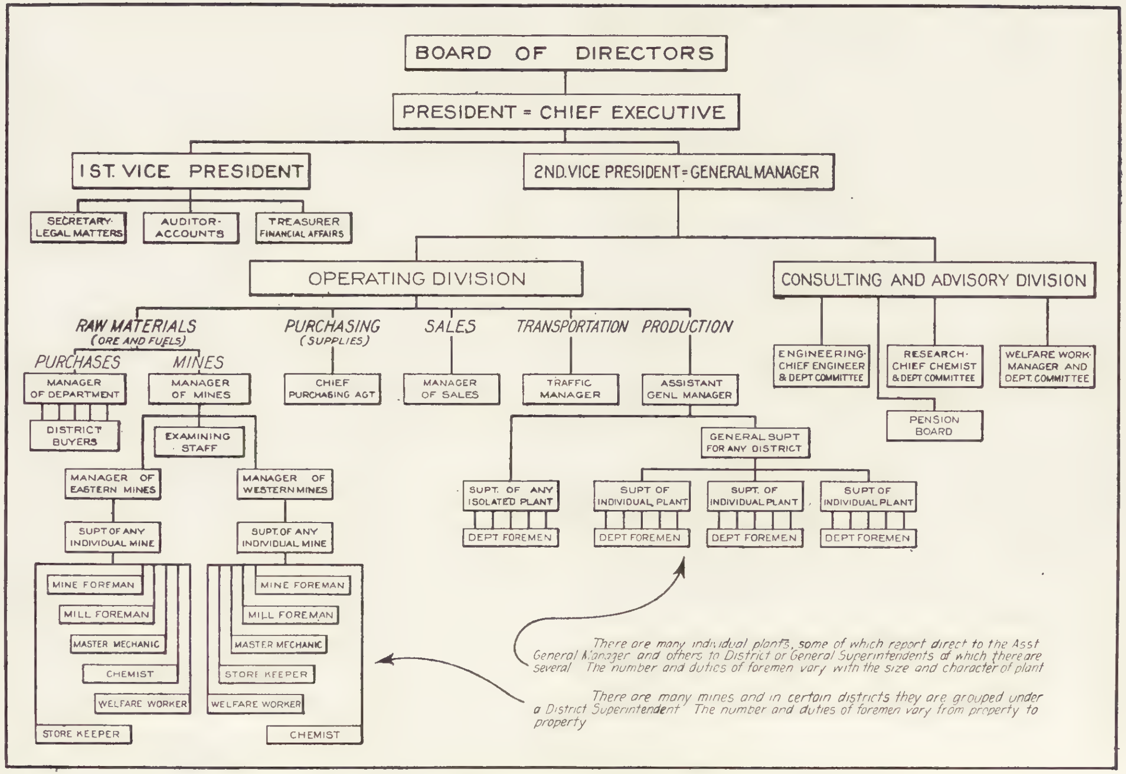


Fig. 1. Staff Organization of a Mining Company

and, hence, having the minimum reason for covering up any mistake. The 2nd vice-president handles those matters which deal with production, marketing of the materials upon which the business is founded; this is naturally the larger part of the company's business and the vice-president in charge has the title of general manager. His duties cover the different fields and his function is to make decisions, save only in those larger matters of general policy or initiation of additional enterprises which must be referred to the president and the board for approval and appropriation before work can be begun. The general manager controls two district staffs, each of which has its own function. The operating division is charged with the duties of keeping things moving along lines already planned and determined. The consulting and advisory division has no responsibility and no authority so far as the conduct of routine work is concerned; its duty relates to plans and methods. One section of the operating division is charged with the duty of supplying the raw materials, in this case ores, needed for the company's various processes. Owing to the size of the fuel bill and the similarity of coal mining and fuel purchasing to the mining and purchase of ore, the supplying of fuel as well as ore is the duty of this section. Many companies, to which fuel is less important, make this one of the duties of the regular purchasing agent. In the case of the particular company under discussion, coal is both mined and purchased. All the mines are under one manager who works through district managers and mine superintendents grouped as shown. He also maintains an examining staff, since the company needs constantly to buy mines and mineral lands to maintain its position. This staff is reinforced, as occasion demands, by detail from the managing staff; that is, the best judgment of the best men employed by the company (not excluding outside engineers kept on retainer) is brought to bear on each major purchase before it is consummated. At each mine there is such organization and such distribution of work among foremen as the particular situation warrants, but one important principle obtains, namely, that every individual around the place is responsible to the mine superintendent, who, in turn, is responsible to the district manager, and so on up to the general manager. The purchasing

agent is responsible to the general manager and deals with him directly. So far as possible, he buys standard materials or upon standard specifications drawn up, on request, by the chief engineer. Special machinery or unusual supplies are only bought after approval secured in routine manner. If in doubt when to buy material that may be needed later, he advises with the general manager, who, in turn, consults any member of either staff who may have special knowledge. All supplies must be delivered to and approved by the particular foreman who made the requisition. It is felt that if the foreman certifies to the receipt of what he ordered he is much more apt to make it work successfully than if any other person had received it. The sales department also reports to the general manager. In contrast with other companies in which the sales department received all products at cost and where all profits appear on the books as originating in the department, the manager of sales in this case works virtually on commission and strict accounts are kept with each mine or works so that the good or bad work of the local management promptly appears. The works are so distributed that stocks can be kept at them and so all products remain the property of the works at which they originate until they are transferred to another works by inter-company sale or are sold outside. In passing, it may be stated that the parent corporation works through a few subordinate companies, each controlling its own raw materials and manufacturing works, though there is at times considerable inter-company exchange. The traffic manager has charge of railways and other inter-plant communications and attends to all shipments. For example, the manager of the department of ore and fuel buying being instructed to buy a certain number of tons of ore of a certain grade, studies the possible sources, and learns from the traffic manager (if he does not already know) the freight rates applying, and then buys the ore. It is then turned over to the traffic manager, who routes it to the works as ordered by the general manager, and attends to all matters concerned with its shipment and delivery. The production department is one of the most important and includes a large number of varied works in which many processes are conducted. It is under charge of an assistant general manager,

who has large discretionary authority but who keeps in close touch with the general manager. The individual works are each under a superintendent, who has such a staff of foremen as the situation requires. In certain areas the individual works are grouped into a subdivision and the superintendent reports to a general or district superintendent, who sifts out numerous matters before reporting to the assistant general manager. Here, as at the mines, every company employe is responsible, through his foreman, to the local superintendent.

One of the most interesting plans of the staff organization is the method of handling the consulting, advising, and planning. This work is organized in a separate division bearing the same relation to the operating division that the "staff" does to the "line" in a modern army. Its officers have no authority over any employe in the operating division, and, in general, contact between the two divisions is through the general manager, though there are cross-lines of reference, as will be indicated. Each section in the division is under a responsible chief, who is assisted by an advisory board or committee. These committees are made up of men and women detailed for that duty from any position in the service of the company. They may devote full time or part time to these advisory duties and may be sent to headquarters or any other point for such period as may be necessary, always on orders of the general manager. As a rule, they do not leave their regular work save for attendance at committee meetings. The principal mechanical engineer might, for example, have regular duties in connection with a railway and still serve on the engineering advisory board. As a matter of fact, the assistant general manager is an active factor in the welfare department. The master mechanic at each plant can, within limits, appeal directly to the chief engineer for advice; the purchasing agent can request the drawing up of specifications for new materials; the superintendent of a plant can, through regular channels, obtain the help of the engineering force in designing plant additions; and so in every way the services of the engineer and his force are available—at the same time any operating man can be requisitioned to serve on the engineering board.

The research department is an important one. It is

equipped with a library, laboratory, and testing works and is engaged in solving problems put up to it from various plants and regular departments. It includes the usual committee, as well as a small working staff. From time to time it undertakes studies at the plants and, following laboratory tests, individual furnaces or other units in working plants are placed at its disposal for test work. The company has developed a number of important processes, owns many patents, and makes liberal provision for its research department. The social service work is under a woman manager assisted by the usual board. It has representatives at various works, who, however, as usual, work under the direction of the local superintendent. Conference with the department head as to methods is direct and unlimited, but actual work is done under the operating officials. Schools, hospitals, playgrounds, libraries, savings banks, visiting nurses, and many similar activities are carried on and the general manager looks upon this department as very important in promoting efficiency among the company employees. The works is non-sectarian, having in fact no affiliation with the Y. M. C. A. or any church. Incidentally, the company has a most enviable history as regards freedom from strikes.

A complete pension system is in force and is conducted, as are other matters regarding labor, by the operating division. The pension board, in the consulting division, is merely the medium for determining the rules under which pensions are granted. The application of the rules is not in its hands. This, and other boards not shown in detail, is not permanently in session in the same sense as the engineering department, but an organization is maintained with such meetings as may be needed.

In general the staff organization of this company shows:

(1) Complete classification of work and sharp definition of responsibility.

(2) Careful discrimination between planning and executive work.

(3) Dependence on "the man on the spot" to get things done.

(4) Mobility and quickness of action are secured by means of allowance of adequate assistance (and

in places alternates) and liberal use of telegraph and telephone as well as mail service.

(5) Placing at the disposal of all departments full and competent advisory and consulting staffs, with adequate provision for the "look ahead" which must be maintained if any concern is to have a long and successful life.

(6) Securing of close cooperation by service of men all through the operating division, upon some one or more of the boards which consider problems for the company as a whole. This extends from general manager down to representative laborers.

(7) Provision of cross-lines of communication without division of responsibility or interference with discipline.

THE LEHIGH COAL AND NAVIGATION COMPANY.*

The organization starts with a board of managers and president, three vice-presidents, secretary, treasurer, comptroller, general sales agent and purchasing agent, all reporting directly to the president and having their offices with him in Philadelphia.

In reference to the three vice-presidents, one is in charge of the financial end; the second in charge of the transportation end, covering railroads, canals and electric power plants, and the third is in charge of the operation of the mines.

The organization of the vice-president in charge of the mines is given in the accompanying diagram (Fig. 2).

This covers briefly your first six questions.

7. The output of the mines is sold thru the selling agency, with a general sales agent, assistant general sales agent and four district sales agents, located in Philadelphia, New York, Boston and Syracuse.

8. A physician is employed and a mining engineer as his assistant in charge of first-aid work, organizing first-aid teams in each and every mine of the Company and each outside opera-

* Edwin Ludlow. Vice-President, Lansford, Penna.

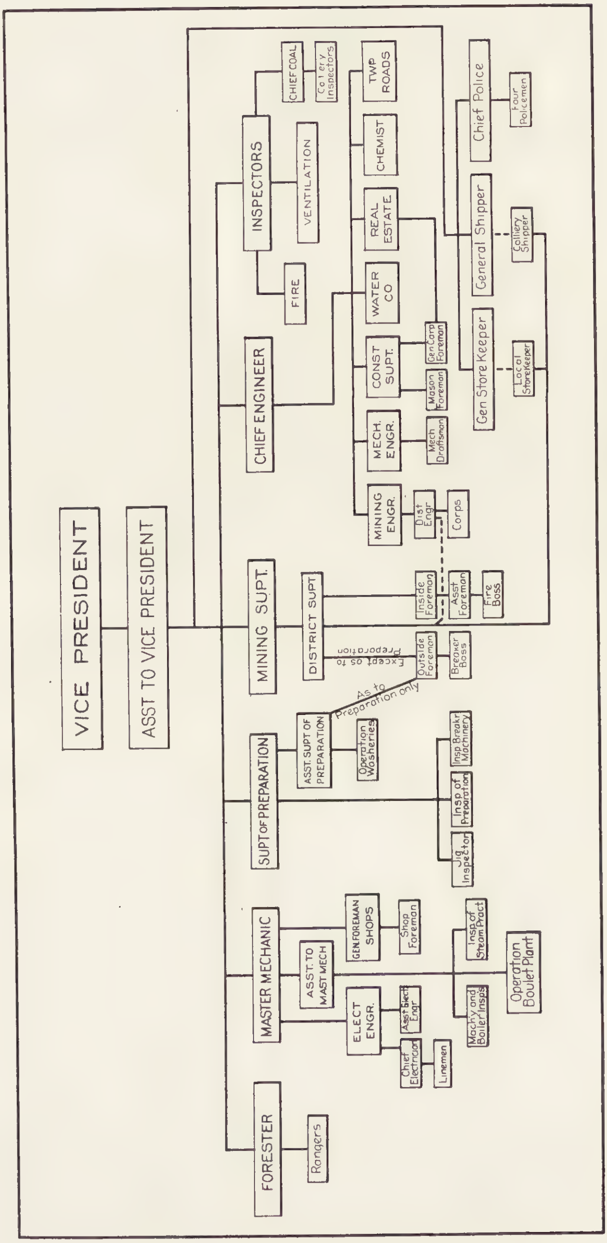


Fig. 2. Organization of the Lehigh Coal and Navigation Company.

tion. These teams are trained regularly every week and a first-aid meeting is held once a year in August, at which twenty-seven teams compete for prizes.

The mining engineer assisting the doctor has direct charge of the mine-rescue car and is always in touch, so that the car can be sent out at any time, day or night, to respond to a call of a fire or explosion.

The car is equipped with Draeger helmets and other mine-rescue apparatus, besides full first-aid equipment.

A Mining Institute is organized with monthly meetings where papers are discussed on welfare, first-aid work and general mining questions and are illustrated as far as possible with moving pictures and lectures.

Night schools are operated in connection with this Mining Institute where the young mining engineers are employed as teachers and all scholars are given free tuition two nights a week in the various grades of mining, mechanical and electrical engineering, mathematics and a special class in English for foreigners.

In regard to workmen's compensation, this Company has maintained a beneficial fund since 1884, contributed to jointly and approximately equally by the men and the company. Thru this fund the men received a compensation at the rate of 50% of their wages when injured and widows or dependent relatives in case of fatal accidents received 50% for a term of eighteen months. This will be done away with on the first of January next when the Pennsylvania Compensation Law goes into effect, giving practically the same benefits, but extending them over a longer period, and the entire cost of same to fall on the Company.

9. In regard to labor questions; there is a mine committee at each colliery, that takes up any grievances with the mine foreman and the district superintendent; if they can't agree the matter is referred to the mining superintendent and one of the officials of the organization is allowed to go with the committee.

If no agreement can still be reached, the matter is referred to the Conciliation Board, established in the Anthracite Region in 1902, consisting of three miners and three operators, and if

it still comes a tie vote, the matter is referred to a referee appointed by the Court.

10. In cases of strikes in the Anthracite Region, there has never been any attempt to replace the miners with strike breakers, the only labor imported is such as might be necessary in keeping the pumps going in order to avoid the mines drowning out. It has been necessary sometimes in the past to employ mine guards thru detective agencies to protect the property.

11. At each colliery a "safety-first" committee is organized, consisting usually of five men; to this committee any hints from the employees on safety first are referred for investigation.

12. An executive committee consisting of the vice-president, assistant to the vice-president, and the heads of the Mining, Engineering, Mechanical and Preparation Departments constitute an Executive Committee for the purpose of going over all questions of improvement and general details, requiring the co-operation of the different departments.

13. An annual budget is prepared at the beginning of each year detailing the amount of new construction work to be charged to "capital" and the amount of improvement work in the form of extraordinary repairs and renewals that will be charged directly to "operation". These lists are submitted to the president for his approval, and the amount to be expended for "capital" and the amount to be expended under extraordinary repairs are designated and the work laid out for the year accordingly.

14. I am not able to answer this question.

15. The Company is controlled thru its Board of Directors and its stockholders, the stockholders being very widely scattered; a recent report showed that 3700 stockholders held less than 100 shares of stock each.

16. It has been the history of this company from almost its inception for the President of the Company to be a Mining Engineer.

17. Men are employed directly by the foreman in charge of the work, when needed by him, under authority from the mining superintendent, thru the district superintendent.

19. The chief engineer has under him a mining engineer and assistant and district engineers with the necessary instru-

ment men, the mining engineer handling the geological and other mining problems in connection with his staff. There are four districts; each district has its district engineer, who is responsible for the maintenance of the surveys under his charge and reports directly to the mining engineer.

20. The president has a general legal department in Philadelphia, and a lawyer at the county seat acts with the mining department and reports to the legal department in Philadelphia.

THE EXCEPTION PRINCIPLE AS APPLIED TO GRAPHIC CHARTS.*

This chart deals with only one portion of the organization of mining companies, but it is novel and seems likely to be useful. It illustrates the "exception principle", namely, exceptional cases only should be investigated by the higher officials.

The economy of these principles (the other principle is that no high-priced man should do any work that can be done by a lower-priced man) is obvious. They are commercial principles and should be applied for the purpose of saving money. Time is money; a high-priced man's time represents more money than that of a low-priced man, and hence we should apply economy principles to this time.

It is not an uncommon sight to see the manager, or some high official, of a large company spend a good many hours each day reading a mass of letters and reports, on which he places his initials or stamp. He feels that if this mass of detail passes over his desk he is in close touch with the entire business. The "Exception Principle" is directly the reverse of this. Under it the manager receives only condensed, summarized, and comparative reports, and even these summaries should be carefully gone over by some assistant before they reach the manager. Exceptions to past averages or standards should be pointed out, both the exceptionally good and the exceptionally bad exceptions. A manager need not feel worried when he knows that everything is running under normal conditions, and should only need to investigate these exceptions from the normals, which should be clearly pointed out to him. This will give

* H. N. Stronck. Care of L. V. Estes, Inc., McCormick Bldg., Chicago.

him in a few minutes a full view of the progress which is being made, or of the reverse, and gives him more time to consider the broader policies of the business and more important work. One of the best methods of summarizing statistics and of arranging them so that they can be seen at a glance is the graphic chart method, now in use in a great number of mining and milling companies. Some of them have very elaborate charts of almost every detail. The most general types of charts are those which show outputs, costs, progress, consumption, and efficiencies. These charts are usually plotted on a daily or monthly basis. They are merely an easy method of showing records at a glance without the need of going through a mass of statistical figures. Some concerns gather elaborate statistics but seldom put these to actual use. A manager is more likely to make a study of a good chart than of a mass of figures. In a chart one can see abnormal conditions at a glance, and center the analysis on these rather than attempt to analyze long lists of figures, where the maximum of these show normals and only once in a while an abnormal figure is indicated, which may pass the eye unnoticed. Abnormal points on a chart, whether they indicate an unusual excess or an unusual minimum should be noted and an investigation will often result in a general reduction in costs. Graphic charts are also of use in the reports to the board of directors or to the stockholders, since they are a condensation of statistical figures.

The evil of too many reports and statistics is also recognized. They may become too ponderous, or be arranged in such a manner, or the figures taken under such conditions, that they are practically worthless, and do not warrant the spending of the time of a high-priced man in analysis. In order to more clearly explain and to illustrate the "exception principle", a few examples will be given.

The first step to be taken in arranging charts according to this principle is to determine a normal. For materials it is usually based on a normal unit of consumption per unit of time of output; for progress or efficiency, on a normal progress or efficiency; and similarly for costs of outputs. These normals are determined either by examining past records by detail investigations, by time studies, or by a combination of the three.

The zone limits depend upon the nature and the value of the subject under consideration, the speed at which the work should be done, and the character and amount of supervision necessary. They are more or less arbitrary and dependent upon the above factors. The first zone is usually that of the foreman, the next that of the superintendent, then one for the manager, and so on, depending upon type of the organization.

Fig. 3 represents a progress chart. A schedule for the

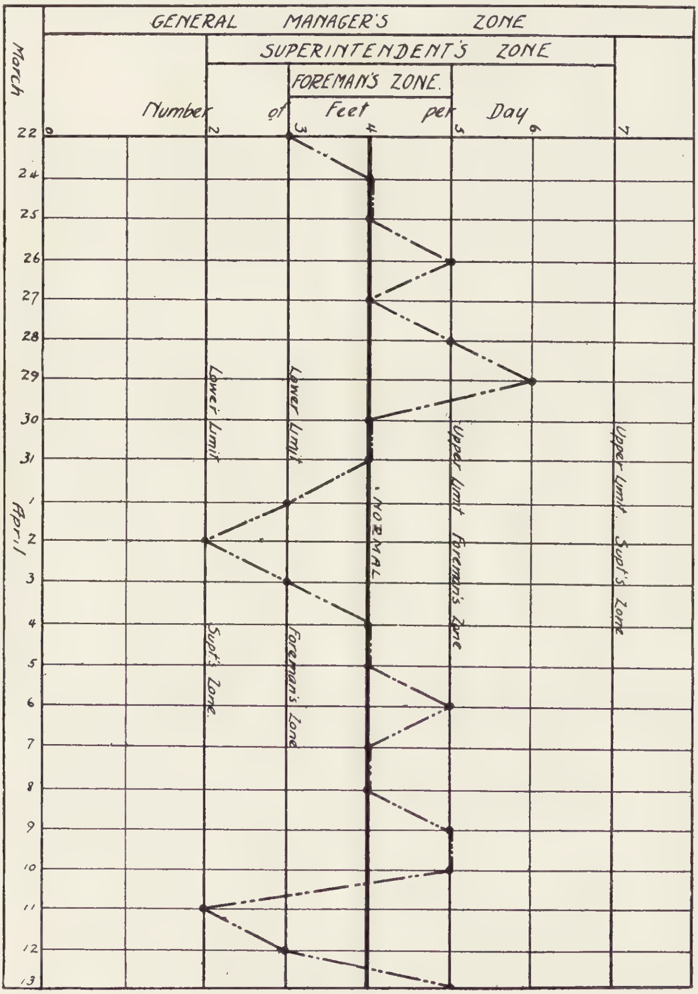


Fig. 3. Progress Chart for a Drift.

completion of a certain drift was made. A progress of four feet per day was necessary to complete this drift on scheduled time. Hence four feet was selected as the normal and a heavy line drawn on the chart to represent this. This is the base line from which the abnormals diverge. The limits of the three zones are indicated. As long as the curve remains in the foreman's zone, the report need go no further; when it enters the superintendent's zone the report is given to him; when it enters

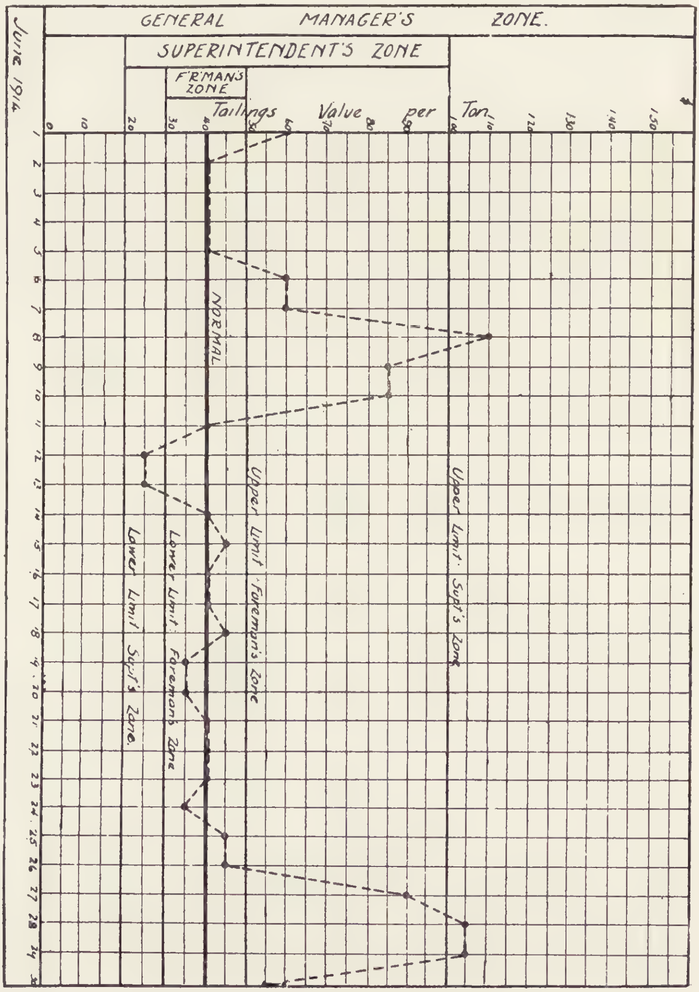


Fig. 4. Mill Efficiency Chart.

the manager's zone, a report is forwarded both to the superintendent and to the manager.

Fig. 4 is a mill efficiency chart arranged according to this principle. The unit is the ton value of the daily tailings sample. The normal was set as 40 cents per ton.

As can be seen, this principle has a great latitude of application. In many cases, the posting of these charts will act as an incentive to the workers to increase the output or to better the quality of the work. Where mill returns were posted it was found that the mill men paid more specific attention to the equipment when the tailings sample of the previous day was high. However, in making charts that show the application of the human factor, it is best, wherever possible, to show the results of each worker rather than that of gangs. This brings out individuality and fosters higher efficiency. In arranging such charts the zone should be so set that unusually high or unusually low efficiencies are brought to the manager's attention only, say, once a month or once every six months. In case a report of exceptionally high efficiency is forwarded to him, it might help greatly to foster coöperation, if he takes a personal interest in the case, and congratulates the workers either personally, by letter or giving monetary reward. In this manner the high officials can keep in close touch with the personnel of the company.

MINE STAFF ORGANIZATION.*

Requirements of an Organization System.

Any organization system to be efficient must provide for a broad differentiation of responsibility. Every official must be responsible to somebody for something. Perhaps the ideal of organization is that which makes each official an absolute monarch in his field, but to work out such an ideal implies ideal men. Yet it would seem to be practicable to commit a given work to a given man, leaving methods and details to him, but holding him rigorously accountable for results.

The duties prescribed for the elements in an organization should be so automatically inter-related as to make a minimum demand upon the extremely fallible human memory.

* Lester C. Uren. University of California, Berkeley.

Authority and responsibility should be clearly defined and coördinated. Every individual should be able to reach a man higher up without being obliged to travel far.

While the form of the organization necessarily depends upon the personalities available, it should, as far as possible, be independent of fluctuations in personality. The loss of one man should not wreck the administrative machinery.

Three General Types of Organization Systems.

There are three general types of organization systems; these may be termed (1) Line Organization, (2) Staff Organization, and (3) Committee Organization.

Line Organization. Probably the best example of line organization is that of an army organized exclusively through the successive subordination of general, colonel, major, captain, lieutenant, sergeant, corporal and private. This is pure line administration. It is the oldest and most common form of organization, but probably never exists outside of the army in this simple and rigid, unmodified condition. The simplest and most usual modification consists in the introduction of a group of specialists advisory to the chief executive, but without formal administrative duties.

As another example of this type of organization, we may consider the case of a mining company operating a small mine still in the development stage. The chief administrative officer would be the president of the company, who is responsible through the board of directors to the stockholders. Directly responsible to him would be the resident manager or superintendent, who might also serve in the capacity of surveyor, engineer, assayer and accountant. Next to the manager in authority would be the mine foreman, and under him would be the shift bosses having immediate charge of the workmen. This may be represented diagrammatically as follows, the arrows showing the direction of authority:

PRESID'T ← RESIDENT MANAGER ← FOREMAN ← SHIFT BOSSES ← WORKMEN

This would be true line organization, but it would be usual for such a company to employ a consulting engineer and geologist to serve in advisory capacity where the development of the mine is concerned. In the same way, an attorney may be

retained to represent the company and advise the president and manager in legal matters.

This simple arrangement works out satisfactorily when the mine is a small one; but when the organization becomes more comprehensive, the general administration must be subdivided. Line organization demands all-round men for the higher positions, and as industries increase in magnitude, it becomes more and more difficult to find men broad enough to satisfactorily control the whole enterprise.

Staff Organization puts experts in authority over each department. The mill superintendent, for example, should be a trained metallurgical engineer. The mine superintendent may or may not be a technical man, but he should have a wealth of practical experience at his command. Both must be of the best type, and neither is big enough to boss the other. Each is a master in his own field.

In the same way, there is made a clear differentiation of authority and responsibility throughout the entire organization. The store-keeper, the assayer, the purchasing agent and accountant are all independent of both the mine and mill superintendents and each other. Each is responsible, in all matters within his jurisdiction, to the general manager and to him alone.

The Committee System of Organization. This system has serious disadvantages and is seldom used in mining. The idea, however, is exemplified by the usual organization adopted for company control—that is, the board of directors with its several officers—the president, vice-president, secretary, treasurer, etc.

If this idea be carried still further, we might consider the various department heads as members of a committee having control of proposed improvements and questions of organization, methods and policy. The general manager, as chairman of this committee, would exercise all the usual powers of a chief executive, except insofar as his authority may be abrogated by the committee.

The general manager is placed in the same relation to the committee as is the president of the company to the board of directors. The committee may have power to make recommendations over the general manager's head to the executive

committee of the board of directors, and thus the general manager may be shorn of a considerable part of the almost absolute authority delegated to him under the other organization plans.

The idea may be carried still further, and subsidiary department committees established, standing in the same relation to the department superintendents as the main committee does to the general manager. An effort is made to have on these committees representatives of every class of interest in the organization; and since these subsidiary committees have representation on the main committee through the department superintendents, every man is thereby placed in close, informal touch with the general manager and the directorate.

The results are: a human contact with the man far down the line; a getting together of men which may help to offset departmental antagonism; and a check on arbitrariness of superintendence. The chief aim is probably that the man who shovels rock may deal with a man who knows what it is to shovel rock. The chief objection is that discipline might be impaired and the authority of the line organization undermined.

Variations of These Organization Systems.

It seldom happens that we find either one of these three organization systems in use at mines in the simple form described. Nearly always some variation is introduced or a combination of two of the three systems is used.

A combination of all three of the primary systems would probably possess greater advantages than any single system operating alone, or any combination of two of the systems. In this way it is possible to utilize the better features of all three of the primary systems.

An example of such a combination of the three primary systems is to be found in Figure 5. In this plan, the backbone of the line organization is clearly shown, through the president and general manager to the various department superintendents. In the delegation of authority to five separate and independent department heads, each responsible to one superior officer—the general manager—the best feature of staff organization has been utilized, and staff organization is carried still further in the administration within each department. For

instance, the mine foreman, geologist, surveyor, and mine sampler constitute the staff of the mine superintendent, as distinct from the general manager's staff, which is made up of the mine superintendent, the mill superintendent, the shop superintendent, the commercial superintendent, and the assayer or chemist.

A possible basis for organization of advisory committees within the staff and line organization is indicated by broken lines surrounding the several groups of officials and workmen. (See Fig. 5.)

It will be noticed that each man is responsible directly to but one superior officer. If a pump in the mine must be re-

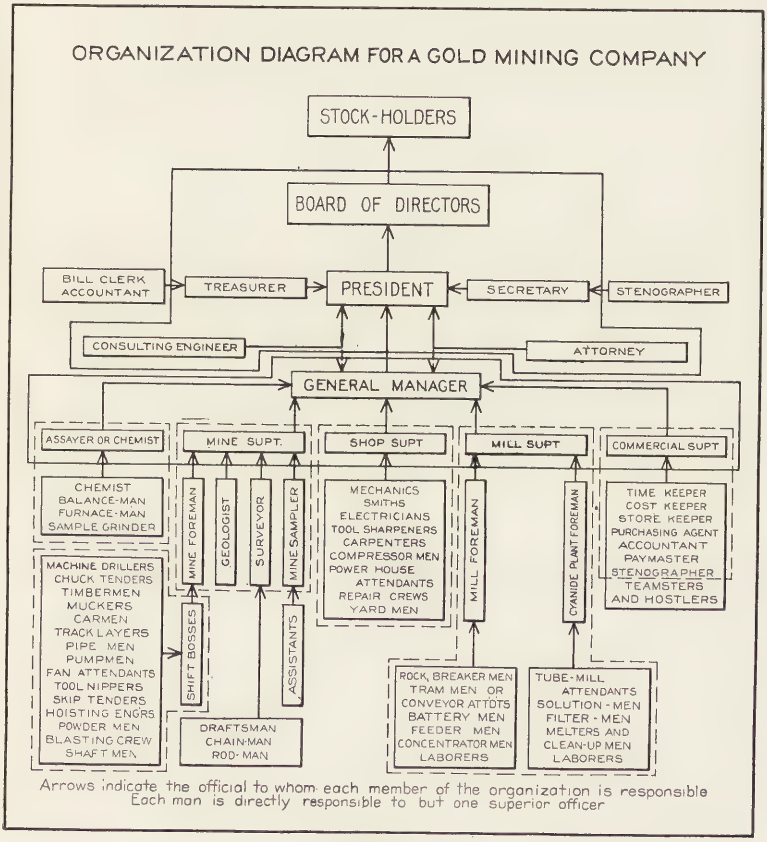


Fig. 5.

paired, the mine foreman is not permitted to order a mechanic to go in and make the repairs: he must first refer the matter through the mine superintendent to the shop superintendent, who gives the necessary orders. No man can serve more than one master without ultimately encountering a conflict of authority.

THE ORGANIZATION AND STAFF OF THE JURAGUA IRON COMPANY.*

The Juragua Iron Company has been engaged since 1884 in mining iron ore near the south coast of Oriente Province, Cuba.

Production.

The normal production is about 35,000 tons per month of hard hematite and magnetite, which is mined by the open-cut method and shipped over the company's private railroad to Santiago harbor, where it is reloaded on steamers for Philadelphia.

Location.

The mines are scattered over a narrow belt, ten or twelve miles long, which extends eastward from Sevilla, a small hamlet situated eight miles east of Santiago de Cuba. The chief activity centers around the village of Firmeza near the center of the region, where most of the ore is collected and crushed and where the general operating office is located. The only ore which does not pass through Firmeza is that from the recently opened Ocana mine, which has its own crusher and a branch railroad connecting with the main line at a point about half way between Firmeza and Santiago.

Incorporation and Ownership.

The company is incorporated under the laws of Pennsylvania. Its capital stock is $600,000, all owned by the Bethlehem Steel Company, which consumes the entire output of the mines.

Board of Directors and Headquarters' Staff.

According to the charter the affairs of the company are represented, administered, managed and governed by a board

* De Berniere Whitaker, Santiago de Cuba.

of directors, a president, a vice-president and a secretary and treasurer. The board of directors includes the others, and all are officers of the Bethlehem Steel Company except the vice-president, who is also the general manager in active charge of the property. The president, the secretary and treasurer and the purchasing agent have their offices in South Bethlehem, the president being a vice-president of the Bethlehem Steel Company and president of several other subsidiary companies.

The vice-president and general manager, the assistant treasurer and all the rest of the staff live in Cuba.

Communication between the home office and the mines is kept up by means of visits from the president, visits of the vice-president to Bethlehem and by correspondence and reports.

The duties of the president are the usual ones that go with the title. He is the chief executive officer exercising practically the full authority of the board of directors.

The secretary and treasurer is the technical supervisor of the work and methods of the accounting department. He is custodian of the company funds and cashes the drafts of the assistant treasurer for the monthly payroll and other expenses.

The purchasing agent attends to the requisitions from the mines after their approval by the president, buying and shipping all machinery and supplies ordered from the United States. He also looks after a supply of steamers for the shipment of ore and keeps a record of all ore, coal, lumber and other property of the company either in Cuba, in the United States or in transit.

Operating Staff.

The vice-president and general manager has a general power-of-attorney from the president and board of directors and is in charge of all the company's operations and business in Cuba.

The general superintendent is the head of the operating department. Reporting directly to him are the mine superintendent, railroad and dock superintendent, chief engineer, physician and surgeon, store superintendent, farm superintendent, chemist, and the foreman of the roaster, Firmeza crushers, ice plant, stables and sanitation squad, besides men in charge of

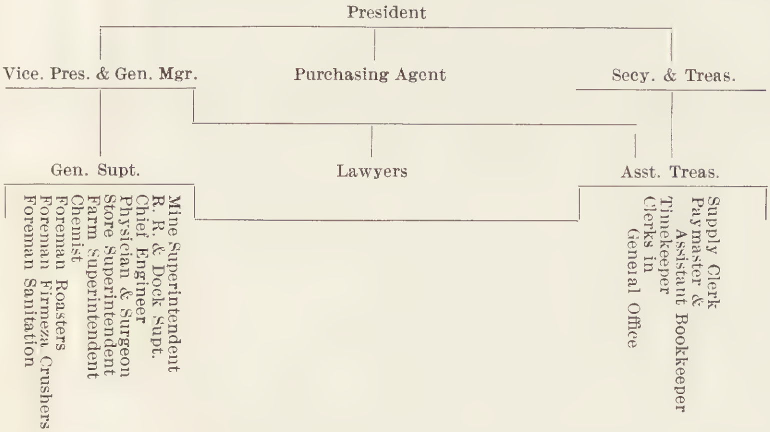
any other work not belonging to any of the operations named. The telephone system and the lighters and boats used around the docks belong to the railroad department; the foreman of the bakery takes his orders from the store superintendent, while the janitor of a workmen's club reports directly to the general superintendent.

The employees classified as belonging to the accounting department, namely, the paymaster and assistant bookkeeper, the supply clerk, several timekeepers and the clerks in the general office, are also under the general superintendent, except as to matters relating to records kept or money handled by them regarding which they receive instructions from the assistant treasurer, who is a bonded officer responsible for all money handled in Cuba and for accurately accounting for both money and supplies.

Employees not already mentioned include foremen, mechanics of all classes, miners and other laborers to the number of about 1000 men.

While this exact plan of organization has been evolved slowly and with great care and is proving entirely satisfactory, it is evident that neither it nor any other that could be devised would be suitable as to details for all cases. Laying aside the question of varying local conditions, plans of work, etc., the personal coefficient is a most important consideration in the construction and arrangement of any group of men. They are selected and trained with a view to their qualifications for certain duties, but it always happens that from time to time certain readjustments and rearrangements of the details of the work to be accomplished are necessary or desirable to adapt it as a whole to the idiosyncrasies of the various individuals of the staff and to the personal relationships that develop among them. Other considerations in the grouping or arrangement of work under different heads are the relative locations of certain jobs, the amount of superintendence needed by them, etc. These points will suggest reasons for the apparently arbitrary classification of one or two of the minor activities referred to on a previous page.

The following diagram is a briefer and perhaps clearer exposition of the organization described above:



Safety.

As the mining is done in daylight no elaborate safety methods are required. Blasting is not allowed except at certain well-known hours when the men are out of the cuts. Immediately after blasting, all loose rocks are pried down from the faces. Accidents are nearly always traceable to carelessness and when they occur the rule is summary dismissal for the foreman in charge. Since this rule was put in force the number of accidents has been reduced by about one third. This and the sanitation work which was begun in 1907, which has been directed chiefly against the mosquito, have reduced the average number of patients in the hospital from 1.33 percent to 0.67 percent of the total number of employees, and, in consequence, when a new hospital was built three years ago, it was only necessary to provide one half the number of beds that the old one contained.

Clubs.

Four clubs are maintained by the company, one for the staff and three for the workmen. The first has been in operation about ten years and now occupies two buildings. One of these is for recreation purposes only. Its equipment includes a piano, phonograph, billiard and pool table, card table and place for dancing. The other supplies comfortable living accommodations for as many as eight bachelors. The company pays for the upkeep of the houses, grounds, furniture, etc., and for the

cooking, fuel and household laundry work. Groceries, marketing, lights and additional servants, if needed, are paid for by those who use them. This plan encourages economy but allows the men to live in such style as they may elect at the actual cost of the materials consumed.

The three clubs for workmen are recent innovations and up to the present time merely reading rooms where periodicals and tables for games are provided. No dues of any kind are collected.

Schools.

A free night school was inaugurated about two years ago, but for lack of a suitable teacher is not now in operation. Three free day schools are run by the government and are well attended.

Compensation for Injuries.

There is no definite system of workmen's compensation. Injured men are taken care of and given such work as they are able to perform. In case of total disability or death, settlement is made according to the particular conditions of the case. We have never had a law suit based on claim for personal injury.

Politics.

A majority of our men are foreigners and consequently there is little activity or even general interest in the political affairs of the island. This is more so since any great danger of revolutions seems to have passed.

Labor Unions.

There are no unions or other organizations among the employees. A labor union existed once for a short time. The leaders promoted a strike apparently for the purpose of proving their usefulness, but it was unsuccessful and finding themselves discredited the officers decamped with the funds of the organization. Since then nothing seems to have been done to revive it.

Strikes.

Strikes were practically unknown in the region before the Spanish-American war. This company has had to deal with only two or three of any importance since. The method so far has been very simple: The authorities are asked for, and usually

furnish promptly, about a hundred rural guards. The commanding officer on arrival announces to the men that he has no interest in the settlement of the strike either one way or the other; that they are at liberty to continue it as long as they wish; that his visit is solely for the purpose of maintaining law and order and that he will guarantee full protection to all who obey the law, including any who may wish to return to work. Next day all except the agitators and the ultra timid go back to work. The company then gives notice that as the strike is over all idlers will be regarded as trespassers and requested to move on. The explanation of the success of this plan is that the majority of the strikers being foreigners unsupported by any strong organization, the government is not afraid to enforce the law and protect life and property. Politics has never complicated the situation sufficiently to delay the protection asked for but once, and that was during the second American intervention while a big strike was in progress in the city also, and those in authority were afraid of antagonizing the Cubans.

Guards.

No mine guards or detectives are employed by the company and there never has been any serious disorder of any kind.

Suggestions.

Suggestions and hints from employes are always encouraged, but there is no special system for dealing with them. As an illustration, the workmen's clubs were established as the result of a remark made by one of the miners indicating that there was a need for them.

Conferences.

No formal conferences are held but there is a frequent, if not constant, interchange of opinions and ideas between the various officials and departments.

Reports.

An annual report is made by the general manager to the president, consisting of about forty typewritten pages and numerous full-page photographs. It includes a full account of the operations for the year, the conditions of the mines, railroad and other property, and a detailed estimate of the expenses for the coming year.

New Mines.

New mining rights are acquired in Cuba from the Government by "denouncement". This consists of a written description by metes and bounds of the area desired and a deposit of about eighty cents an acre to cover the cost of surveying. In the course of time, usually estimated at a year, the claim is staked out by government engineers, and if it is found that prior rights are not invaded, title is granted to all the ore of the class asked for lying within the boundaries named. The surface rights must be acquired separately, usually from private parties, before mining can begin. At any time before the survey is made the deposit may be withdrawn and the claim abandoned. The mining rights of this company were acquired by denouncement, by purchase and by lease.

A study of the foregoing letters and diagrams should give a very good notion of principles on which the modern systems of mine organization are based. The following definition is instructive:

"Organization is fundamentally a practical plan for subdividing the conduct of any undertaking into parts, each small enough to be handled by an individual by a method that enables all to work together. The efficiency of organization depends on the wisdom and skill with which this division is made—the success secured not only in selecting efficient individuals, but in arranging that each may work at his best efficiency and all work may keep balance and harmony in achieving the desired result."*

To give a complete account of the various mine-company officials requires more space than the subject warrants, especially as a very good account of their duties can be found in an article by Mr. Herbert Lang: "The Organization of Smelting Companies", Mining and Scientific Press, April 19, 1913.

An important point to be observed in mine organization has been well stated in a letter by Mr. Albert Burch: "I might say that from my observation and experience, I have always found the one safe principle in connection with Staff Organization is to so fill the official positions in connection with mining

* "Principle of Industrial Engineering", C. B. Going.

operations that the loss of any one man will not seriously cripple the enterprise. In other words, for a concern able to support the two offices, I would always have an assistant manager who would be expected to have sufficient general knowledge of the company's affairs to be able to immediately take up the duties of the manager. In a smaller organization, the general superintendent should be a man qualified to at least temporarily fill the manager's position. Under the general superintendent, or the assistant manager, as the case might be, some superintendent of division should be able to take up the work of the general superintendent or of the assistant manager. This principle should apply down through the offices and positions of mine or mill superintendent, mine or mill foreman and even to the point of having a shift boss in the mill and a shift boss in the mines, each capable of stepping into the shoes of his immediate superior. The same principle should be used in the engineering and office forces.

"I have tried to carry out this system at mines of which I have been manager, and have observed that failure to put such a system into effect has sometimes led to temporarily disastrous results at otherwise well-managed properties".

RELATIONS WITH EMPLOYES. UNIONS. STRIKES.

A most important portion of the duties of the management of a mining company is the dealing with the employes. Indeed, it can fairly be said that the first thing to consider in opening any new mine is the health and safety of the miners. And almost equally important is the question: Shall the miners be treated as individuals or collectively as a union? This is too big a question to investigate in this paper, but it is too vital to the mining industry to omit entirely. The simplest solution of this problem is to refuse to employ unionists and this solution is preferred by many of the larger corporations. For example, the Homestake mine, at Lead, South Dakota, had operated for several years on the "open shop" basis, union and non-union miners working together without friction, but when the Western Federation of Miners published a notice that after November 25th, 1909, all miners must join the union, Mr. Grier, the general manager, retaliated by shutting down the property.

When the mine started up again in January, 1910, it was with employes who had signed an agreement not to belong to any union during their employment with the Homestake company. For the management, this was by far the simplest way of dealing with the situation, but the Western Federation denounced the shutting of the property during the winter months as an inhuman and arbitrary proceeding.

Theoretically, the unionization of the employes ought to be welcomed, for it should be much simpler to deal with a body of representatives than with the unorganized mass of the workmen, and in the anthracite region of Pennsylvania the United Mine Workers of America is regarded as a union that works for peace and good will. But this same union caused civil war in Colorado and West Virginia and was strongly condemned by the British Columbian government.

Probably the most disheartening feature of unions is that they will not keep their contracts—the local or district unions will not obey the mandates of the central body. This fact is admitted by the leaders themselves. This failure to keep contracts is rebuked in the remarks of Mr. W. O. Smith, ex-Chairman of the Executive Committee of the Kentucky District of United Mine Workers of America; he stated:*

> " 'Because of the indifference of the conservative members of our unions and the activity of the radical element, which is responsible for the greatest menace which has ever threatened the United Mine Workers of America—the local strike, during the past two or three years the international, as well as the district and subdistrict officials, have been confronted with many perplexing problems, some of which seem to threaten the very life of the organization. But I believe I am safe in saying that no problem has given them so much concern as the problem of local strikes in violation of agreements.
>
> " 'Thousands of dollars are expended every year in an effort to organize the 250,000 non-union miners in the United States, while hundreds of our members go on strike almost every day in absolute, unexcusable violation of existing agreements'.

* "Final Report of the Commission on Industrial Relations", p. 419.

"This criticism comes not from an employer, but from an ardent, earnest unionist, in high standing in this organization.

"Corroborating the statement of Mr. Smith, comes a statement published in Coal Age of December 20, 1913, issued by the Association of Bituminous Coal Operators of Central Pennsylvania, addressed to Mr. Patrick Gilday, President of District No. 2, U. M. W. of A., Morrisville mines, Pa., dated Philadelphia, December 12, 1913, in which, among other things, the following appears:

> " 'Whereas, Rules 12 and 13 of said agreement provide, 'that should differences arise between the operators and mine workers as to the meaning of the provisions of this agreement or about matters not specifically mentioned in this agreement, there shall be no suspension of work on account of such difference, but an earnest effort be made to settle such differences immediately.' Whereas, notwithstanding the fact that Rule 15 provides the right to hire and discharge, the management of the mine and the direction of the working forces are vested exclusively in the operator, the United Mine Workers of America have absolutely disregarded this rule, in that they have at numerous times served notices on substantially every operator belonging to our Association, that unless all the employees working for such operators should become members of the union on or before certain dates mentioned in said notices, they, the Mine Workers, would close or shut down the operators' respective mines, and in many instances did close the mines for this reason, and refused to return to work unless such non-union employees were discharged. This conduct is in direct violation of the contract, and specifically interferes with and abridges the right of the operator to hire and discharge, with the management of the mine, and of the direction of the working forces; this conduct in violation of contract on the part of the Mine Workers, as well as that mentioned in the preceding paragraph, has resulted in more than one hundred strikes during the life of our scale agreement' ".

Other objections that employers have to organized labor are:

"(a) Sympathetic strikes.
(b) Jurisdictional disputes.
(c) Labor union politics.
(d) Contract breaking.
(e) Restriction of output.
(f) Prohibition of the use of non-union made tools and materials.
(g) Closed shop.
(h) Contests for supremacy between rival unions.
(i) Acts of violence against non-union workers and the properties of employers.
(j) Apprenticeship rules."*

In this connection the remarks of Mr. Samuel Gompers, President of the American Federation of Labor, at its convention in 1902, are of especial interest; he said:

"'Beyond doubt, the greatest problem, the danger which above all others is threatening not only the success but the very existence of the American Federation of Labor, is the question of jurisdiction. Unless our affiliated national and international unions radically and soon change their course, we shall, at no distant date, be in the midst of an internecine contest unparalleled in any era of the industrial world, aye, not even when workmen of different trades were arrayed against each other behind barricades over the question of trade against trade. They naturally regard each other with hatred, and treat each other as mortal enemies.

"'There is scarcely an affiliated organization which is not engaged in a dispute with another organization (and in some cases, with several organizations) upon the question of jurisdiction. It is not an uncommon occurrence for an organization, and several have done so quite recently, to so change their laws and claims to jurisdiction as to cover trades never contemplated by the organizers, officers, or member; never comprehended by their titles, trades of which there is already in existence a national union. And this without a word of advice, counsel, or warning.

"'I submit that it is untenable and intolerable for an organization to attempt to ride rough-shod over, and trample

* Ibid, p. 414.

under foot, rights and jurisdiction of a trade, the jurisdiction of which is already covered by an existing organization. This contention for jurisdiction has grown into such proportions, and is fought with such an intensity as to arouse many bitter feuds and trade wars. In many instances employers fairly inclined for organized labor are made innocently to suffer from causes entirely beyond their control'.

"As proof of the prophetic and far-sighted utterances of President Gompers, it has been pointed out that in 1911, in Chicago, his grim prophecy was actually fulfilled in the bitter jurisdictional wars fought by rival unions in that city, in which paid thugs and gunmen turned the streets of Chicago into a condition of anarchy, and in which, as a mere incident from the union standpoint, millions of dollars of construction work remained idle, with a resultant loss to owners, contractors, and the business interest of the city beyond possibility of calculation.

"We ask, what sane or thoughtful employer would willingly put his head in a noose such as this by recognizing and dealing with unions, and thus invite possible ruin?"*

For the reasons just stated, it is not only the employer who objects to the union, but the workman himself often opposes the introduction of the union into a non-union camp. The miner sees that he runs a greater risk of being misdirected and mistreated by the union leaders than by his employers; moreover the union dues and assessments are expensive. If the unionist leaders were far-seeing, self-sacrificing men who worked only for the greatest good of their members, without a thought of self-aggrandizement all the workmen of the United States would soon join the unions. But as conditions now are, altho unionism has been violently preached for half a century not more than 21 percent of the workmen engaged in mining, manufacturing, and transportation and not over 7 percent of the total number of persons engaged in gainful occupations belong to a union.

And of late years the excesses of the Western Federation of Miners and the Industrial Workers of the World have been

* Ibid, p. 417.

so virulent that it is the duty of all mine organizations to resist them.

Strikes.

A normal man is never satisfied with what he has, but ever strives for more and more, hence, it is inevitable that the miners and the managers must constantly disagree as to wages or working conditions. In an ideal state such disagreements would be reconciled by some impartial judge, commission or other tribunal, but under our present imperfect system such disagreements frequently give rise to strikes.

A difficult question comes up when trouble is brewing and before a strike is declared: "Shall the mine managers meet the representatives of the men when there is no established union?" Many mine managers contend that when a camp is non-union, the meeting of these representatives is, in fact, a recognition of the union and for that reason decline to negotiate and frequently say: "There is nothing to arbitrate". In our opinion this refusal to meet the representatives of the men is wrong and we feel that where bloodshed and destruction of property so often accompany mining strikes every effort should be made to obtain a peaceful settlement. Much good can be accomplished by face to face talk; and perfect fairness and frankness on the part of the managers often lead to desirable results, while the refusal to negotiate invariably stirs up wrath. But when the representatives are the stormy petrels of labor-troubles, whose presence habitually leads to riot and murder, there is surely much to be said for the mine officials who decline to meet such men—especially when definite crimes can be traced to their hands. Even in such a difficult case we feel that it is better to strain every point in favor of negotiations.

The employment of armed strike-breakers and guards, which has developed to an amazing extent in this country, is a blot on our so-called civilization; such employment should be forbidden by laws, with heavy penalties for its violation, but not until the State fully assumes the duty of protecting the property within its boundaries. And until such protection is fully assured we may expect to see a continued employment of these armed guards. Indeed, this use of armed private guards seems a deplorable necessity, but possibly the need for them is

not so great as it seems, and it may be that if more reliance was placed on the State more effective protection would be given. Much good might result if some of the larger corporations would put themselves entirely under the protection of the State and announce that they were relying entirely on ordinary official aid and would not engage outside guards. Such a policy would bring all good citizens at once to the support of the law-abiding company, while the importation of fighting-men irritates all lovers of order and infuriates the strikers. An object lesson of the results of such a policy was afforded by the Bayonne, New Jersey, strike of the Standard Oil Company, where the employment of gun-men by that company had raised up a frenzied mob, intent on destroying the plant and it was not until the gun-men were dispersed by the sheriff that the mob was quieted and the plant saved from destruction. In this particular case bloodshed and riot would have been avoided had the Standard Oil Company in the first place thrown itself on the protection of the State instead of flying to the detective agency. That enormously wealthy corporation could well afford to give an example of its belief in the power of law and order and its confidence would not have been misplaced.

There is now (October, 1915) a strike in progress at Clifton, Arizona, where the mine managers have abandoned their properties to the care of the State of Arizona and as yet no loss has been incurred. Some of this freedom from violence may be due to the fact that Arizona is now a prohibition State, and that no saloons are open to serve as rallying-points for the lovers of destruction.

SCIENTIFIC MANAGEMENT.

An industrial development that has come into the searchlight of late is the so-called Scientific Management; this has revolutionized the cutting of metals and has been introduced into mining to a slight extent.

Tho those persons who have not grasped the theory of scientific management are still hotly arguing about its merits, there is no real question but that it is a great labor-saving invention. In future it will play a great part in regulating mining work; in fact, it seems likely that in well-organized tunnel work,

where bonuses are paid and records beaten, we already have a good example of scientific management.* And the introduction of the "safety-first" foreman by the United States Coal and Coke Company is a step in the same direction.

The chief aim of scientific management as practised in the machine shops is to set a definite task; this can be easily accomplished in some classes of mining work, such as shovelling, and tramming; but, owing to the great variety in the hardness of the rock in the same mine, it is more difficult to arrange a task for the drillers. But the miners can be provided with instructors who will show the best and safest methods of working. This definite instruction is strenuously objected to by the unions, and the introduction of scientific management is said to have been one of the chief causes for the Michigan strike in 1913. Nevertheless, accurate time studies by motion-study experts and subsequent instruction of miners by competent men is exactly what the mining industry needs. Mr. F. W. Taylor, who merits the title of inventor of scientific management, and Mr. H. K. Hathaway, one of the leading exponents, both considered that the system was well adapted for coal mines, but said that its introduction would be difficult and would require exceptional diplomacy, tact, patience, and perseverance; probably three years' time would be needed before any great benefit would be derived and the cost might easily run to $10,000 per annum.†

The repair shop and the handling of supplies seem to be the most suitable points for the introduction of the system. The chief point to bear in mind is that scientific management must be so arranged that some one workman earns more money with less work, and yet at less cost to the company for the work done. Seeing their fellow-worker making more money and working no harder, other miners will be attracted and finally the whole force will be transformed. Investigation seems to show that the great difficulty with scientific management is that it throws much more work on the officers of the company.

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* "The Bonus System Applied to Tunnel Driving", J. R. McFarland, Engineering News, Aug. 26, 1915.

Bulletin of the American Institute of Mining Engineers, February, 1915.

† "Scientific Management; Possibility of its Application to Coal Mining", Wm. Archie Weldon, Colliery Engineer, May, 1913, p. 553.

Definite figures as to saving effected in mines are given by Mr. Glanville A. Collins,† who states that at a property managed by him the cost of mining was reduced 32 percent; milling 18 percent and development 27 percent. We have no exact figures of the lessened cost in the mines controlled by the Calumet and Hecla, but report says that as much as 40 percent was saved on machine-drilling costs.

SOCIOLOGICAL DEPARTMENT.

This department of mining organization is growing in importance daily. The most impressive illustration of its activities is in the exhibit of the United States Steel Corporation at the Panama-Pacific International Exposition. Here are shown in detail the welfare, safety, recreational and educational work undertaken for the benefit of the mine employes of that vast corporation. The company cares for the expectant mother and the new-born babe thru its doctors, nurses and hospitals; provides parks and recreation grounds and apparatus and schools for the growing child, theatres, churches, hospitals and night schools, and engages in other beneficial activities that would require a series of volumes to describe. Many other large mining companies are similarly active; the Colorado Fuel and Iron Company, for example, has a special sociological staff. The remote mines of the Alaska Treadwell Company are brightened by club and other amusement facilities provided and managed jointly by the company and the employes. Some companies are obliged, owing to their isolation, to furnish their men with supplies thru company stores; when properly managed, so that the cost to the miner is no higher than it should be, these stores are a powerful instrument for making life worth living, and the same remark is applicable to the company boarding house. Too often, however, both the store and the boarding house are run chiefly to make a profit for some of the mine officials or their relatives and the service is apt to be inferior, hence, much dissatisfaction results and the efficiency of the labor is impaired.

† "Efficiency Engineering as Applied to Mining", Trans. American Institute of Mining Engineers, Vol. 43, 1912, pp. 642-662. "Principles of Efficiency for Mine Management", Mining and Engineering World, April 6, 1914, p. 643.

Whenever it is necessary for a company to supply its employes with supplies and food, care should be taken that no undue profits are made, and, in all cases, the men should be free to deal either with the company or with outside merchants, as they see fit.

Employment of Men.

As a rule, especially in small mines, the miners are hired by the foreman and the mechanics by the superintendent; but in the larger mines, for example, the Homestake, a special department attends to this work. In this mine the men are required to pass a physical examination and careful records are kept. Labor troubles in Telluride and other camps have led to the establishing of a general hiring-office for all the mines in the district.

Not much attention seems to have been given to the training of apprentices and one of the demands of the coal miners is that their sons shall be allowed to work in the mines if desired.

The compulsory insurance of all mining employes will soon be obligatory. This is cared for by the State in the case of the smaller companies, while the larger companies carry their own insurance; the payments, however, are regulated by the States.

* See ''Training of Mine Employees'', M. von Bernewitz, Mining and Scientific Press, September 14, 1912.

BIBLIOGRAPHY.

Books.

''Organization of Gold Mining Business'', N. Brown.
''American Mine Accounting'', W. H. Charlton.
''Factory Organization and Administration'', Hugo Diemer.
''Principles of Industrial Management'', J. C. Duncan.
''Works Management'', W. D. Ennis.
''Cost-keeping and Scientific Management'', H. A. Evans.
''Principles of Industrial Engineering'', C. B. Going.
''Human Factor in Works Management'', J. Hartness.
''Principles of Mining'', H. C. Hoover.
''The Business of Mining,'' A. J. Hoskin.
''Mine Accounts and Mine Bookkeeping'', J. G. Lawn.
''The Economics of Mining'', T. A. Rickard.
''Commercial Organization of Engineering Factories'', H. Spencer.

Articles in Periodicals.

Abbreviations:

M. S. P. Mining and Scientific Press.
E. M. J. Engineering and Mining Journal.
M. W. Mining and Engineering World.
A. I. M. E. Transactions of the American Institute of Mining Engineers.

''The Bonus System Applied to Tunnel Driving'', E. M. J., Sep. 25, 1915.
''Contract System in Michigan Copper Mines'', E. M. J., 1913, pg. 1178.
''Contract Workers in Calumet & Hecla'', E. M. J., Aug. 22, 1914, pg. 347.
''Calumet and Hecla Efficiency Work'', E. M. J., July 18, 1914, pg. 123.
''Applying the Methods of Scientific Management to Mining'', Coal Age, Jul. 4, 1914.
''Administration and Mine Bosses'', by A. Miner, M. S. P., Mch. 1, 1913.
''Organization of Staff for Mine Machine Shops'', Bull. 136, Am. Soc. Mechanical Engineers.
''The Rockefeller Plan'', The Survey, Vol. XXXV, Oct. 16, 1915.
''Scientific Management for Mines'', E. M. J., 1913, pg. 514.
''Welfare Work of the Calumet and Hecla'', E. M. J., Sep. 26, 1914, pg. 575.
''Suggestions for Mine Staff Organization'', J. Boyd Aarons, E. M. J., Jun. 22, 1907, pg. 1194.
''Concerning Superintendents'', Alfred Allen, M. S. P., Feby. 15, 1908, pg. 229.
''Lack of Efficiency in Mining Operations'', Letson Balliet, M. W., Aug. 22, 1914, pg. 327.
''Training of Mine Employes'', M. von Bernewitz, M. S. P., Sep. 14, 1912, pg. 336.

"An Unusual Underground Organization", G. S. Brackett, Coal Age, Sep. 19, 1914.
"Necessary Training of Mine Officials", P. J. Brennan, Coal Age, Jun. 27, 1914.
"Principles of Mine Management", C. A. Chase, Colorado School of Mines Quarterly, Sep. 1912, pg. 27.
"Efficiency Engineering as Applied to Mining", Glanville A. Collins, A. I. M. E., Vol. 43, 1912, pg. 649.
"Principles of Efficiency for Mine Management", Glanville A. Collins, M. W., Apl. 4, 1914.
"Capitalizing and Promoting Mining Properties", W. A. Crooks, M. W., Jun. 6, 1908, pg. 905.
"Scientific Management as Applied to Gold Mining", Algernon Del Mar, M. W., Nov. 1, 1913, pg. 795.
"Efficiency as Applied to Mining", W. S. Crocker, M. W., June 21, 1913, p. 1183.
"Essentials of Organization and Management", J. R. Finlay, E. M. J., Jul. 31, 1915, pg. 171.
"Time Studies and Air Consumption", E. M. J., Jun. 14, 1913, pg. 1183.
"Obtaining Efficiency in Mining", Andre Formis, E. M. J., Dec. 28, 1912, pg. 1209.
"Mine Economics", John Gibson, Colliery Guardian, Apl. 17, 1914.
"Commercial Mine Organization", C. V. Jenkins, Mines and Minerals, Jul. 1902.
"Organization of Smelting Enterprises", Herbert Lang, M. S. P., Apl. 19, 1913, pg. 585.
"Suggestions on the Application of Efficiency Methods to Mining", C. M. Leonard, Proc. Lake Superior Mg. Inst., 1913, pg. 103.
"Mine Management Diagram", Edwin Ludlow, Mines and Minerals, Feb. 1912.
"Control and Management", E. T. McCarthy, Mining Magazine, Vol. 4, pp. 21, 119.
"Organization as Affecting Management", A. J. Moorshead, Colliery Engineer, Jun. 1913, pg. 627.
"Fundamentals of Mine Efficiency", Wilber Meyer, E. M. J., Jun. 27, 1914, pg. 1287.
"Science of Good Management", A. J. Reef, Coal Age, Jan. 4, 1913.
"Secretaries", T. A. Rickard, Mining Magazine, Vol. 5, pg. 419.
"Management of the Bogoslovsk Estate", W. H. Shockley, A. I. M. E., Vol. 39.
"Observations from an Engineer's Note Book", W. H. Storms, M. W., 1913.
"Relation of the Mine Foreman to his Assistant", Thos. Turner, Coal Operator, Feby. 6, 1913.
"How to Maintain Discipline in a Coal Mine", E. C. Taylor, Coal Trades Bull., July 1, 1912.
"Dont's that Should Be Observed by Officials at Mines", James Taylor, Coal and Coke Operator, Feby. 6, 1913.

''Relations of Big Business to Industrial Prosperity with special reference to Mining'', C. R. Van Hise, Proc. Am. Mining Congress, 1913, pg. 20.

''Influence of Underground Manager'', Joseph Virgin, E. M. J., Jany. 1, 1910, pg. 15.

''Capitalization of Small Mines'', A. W. Warwick, E. M. J., Oct. 15, 1910.

''Scientific Management. Possibility of its Application to Coal Mining'', Colliery Engineer, May 1913, pg. 553.

''Mine Administration and Mine Bosses'', M. S. P., Mch. 1, 1913.

''Miners versus Technical Men'', M. S. P., Apl. 26, 1913.

''Business Principles Applied to Mining'', H. J. Wolf, Colorado School of Mines Quarterly, Sept. 1914, pg. 197.

Paper No. 162

RELATIONS OF GOVERNMENTS TO MINING.

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Full consideration of this subject would involve its elaboration to an extent far beyond the limits permitted to this paper, and be largely repetitive of much that has often been ably presented by economists and philosophers of this and other lands. Indeed, its fundamental importance may perhaps have been more clearly apparent in the days before our industrial systems and operations reached their present state of complexity, and may today sometimes be lost sight of in the maze of legislative enactments and the multiplicity of modern industries, which industries, although impossible without the aid of mining and its products, yet have attained proportions of such dimensions as to endow them with attributes of apparently primary rank.

Nearly half a century ago there was presented to Congress and the people of the United States a discussion of this very subject* by Dr. R. W. Raymond, who has been long recognized as the dean of American mining engineers. The arguments there advanced are of universal application; and no later author is likely to improve on the manner of their arrangement and presentation. To this article the present writer wishes first to pay his respects; and from it to appropriate language, ideas and references.

It has been said that "mining and agriculture are the two great forms of productive industry. Strictly speaking, agriculture is the most important, since without it men could not exist; yet mining is almost as essential, since without it men could only exist as savages". If this be true, then the man

* Executive Docs. Third Sess. 40th Congress, 1869, pp. 173-256.

who makes two blades of grass grow where one grew before is no more desirable and valuable a citizen than he who adds tuppence to the world's supply of available and useful minerals. The prospector and the miner are as useful and as necessary to general prosperity as is the farmer; and the fostering arm of government should be extended with equal care over both. Indeed there are considerations which justify closer attention of lawmakers and greater liberality of appropriations for the encouragement and protection of mining than for farming. On this point Dr. Raymond speaks as follows:

> "1. The products of mining are in general far less perishable than those of agriculture, and, in proportion to their first cost, of greater, because more prolonged, use to mankind. Who can estimate the blessings diffused by a ton of iron, mined, smelted, wrought into forms of beauty and usefulness, serving for generations the needs of men, and repeatedly reforged, and reappearing, as by a material metempsychosis, to enter upon new periods of beneficence? More difficult still is it to measure the importance of gold and silver, the production of which, aside from their application in the arts, is so subtly connected with the profoundest problems of political economy. The sophistry that gold and silver money is a conventional matter altogether is trivial. So is all society conventional; and the things upon which mankind have agreed are the things which God has ordained. Gold and silver are world's money, or means of exchange; and this accepted medium must bear a certain relation to the volume of the world's business. Experience, speaking louder than the philosophers, has shown that, in spite of all contrivances of barter, credit, and paper money, the supply of the precious metals is of vital importance to all commercial nations.
>
> "2. Gold and silver are especially valuable as articles of export. If a country produces more grain than it can consume, it must seek a market elsewhere for its surplus, and this market may not be readily found. Besides, there is danger of loss or deterioration by transport and storage. The precious metals, on the other hand, command

the markets of the world. They can be shipped or hoarded without deterioration, and they form the best basis of international exchange.

"3. But these advantages of mining are counterbalanced by the fact that its sources are not perpetual. Men till the same soil for generations, and, if it is properly cared for, it is as able at the end as it was at the beginning to sustain the desired crops. But every mineral deposit is certain, sooner or later, to be exhausted. Sometimes this exhaustion is absolute. The valuable mineral is all extracted, and the end of the deposit is reached. This was the case a few years ago with the silver mines of Andreasberg, in the Hartz Mountains. Sometimes the exhaustion is merely an economical one. The deposits continue, but it no longer pays to work them. This is the disaster looked forward to within the next century by English economists with regard to the coal mines of England. In either case the source of wealth is closed, and great national changes are often the result. We may say, then, that mining yields a permanent form of wealth from a transient source, while agriculture presents a perennial source of perishable wealth.

"4. The mistakes of mining are always to a greater or less extent irretrievable. Wasteful and ignorant farmers may exhaust the soil; but nature, time, and skill will restore it. Even the wanton destruction of timber entails upon a nation only a temporary evil, since the trees will grow again. But the economical exhaustion of a mine, or a whole mineral region, can be brought about by reckless mining beyond the possibility of restoration. * * *

"5. Finally, the resources of mining are not so equally distributed among nations as those of agriculture, and, as a consequence, the relative power of nations depends largely upon their mines. The iron and coal mines of England are well known to be the secret of her commercial strength; and in our own country the State of California owes her wonderful progress and increasing power to the mines. Even the enormous agricultural capacity of that State (however much her farmers may

sneer at the idea) would never have been known nor developed but for the gold mines.

"In view of these peculiar relations of mining, it is evident that governments are in a certain sense trustees of the wealth stored in the mineral deposits of their realms—trustees for succeeding generations of their own citizens and for the world at large. It is not a matter of indifference to the citizens of this country whether our mining fields be ravaged and exhausted in one or even five centuries, when they might last a score".

Since the power and relative standing of nations wax and wane with their control of necessary minerals, it has been commonly observed by historians that many of the wars of history have been occasioned by a desire on the part of one country or people to possess mines situated in the territory of another. Thus it has been pointed out by Hoover* that Jason and the Argonauts in their search for the golden fleece were nothing but placer miners, the gold that they sought being in the sands of eastern rivers; the mines of Laurium often furnished the sinews of war for the Greeks; the contest for supremacy between the Romans and the Carthaginians was founded in large measure upon the desire of the Romans to acquire the mining interests of the people of Carthage. After the Romans gained possession of the mines of Rio Tinto they made war in Gaul to capture slaves for working the mines. In more recent times, we recall the conquest by the Spaniards of Peru and Mexico in the search for golden treasures, the struggle between the Swedes and other people of northern Europe over the sovereignty of the great Fahlun copper mine, which was called by Gustavus Adolfus the "Treasure House of Sweden"; the conquest by the Germans of the iron-ore and coal fields of Lorraine; the struggle in the Boer war over the control of the Transvaal gold mines; the conquest by the French of Tunis and Algeria, with their rich deposits of iron ore and phosphates; and the still more recent invasion and capture of the principal zinc producing districts of Belgium. Indeed, from the very earliest days, dominion over minerals has been a prime desideratum of man. Our stone age ancestor quarried the rock

*Agricola.

from which to shape his weapons; tribal communities located their habitations near the deposits suitable for such purpose; and many an unrecorded contest was fought to a sanguinary conclusion between those in possession and those who came from afar to renew their stock of arrow points, red pipestone for pipes, and native copper for domestic utensils or spear tips. Miners operated before Tubal Cain had use for a forge or Solomon and Croesus could accumulate their treasures. The geographical distribution of the human race has from the very earliest times depended on that of easily won mineral deposits, and relative stability and tribal or national supremacy has been conditioned by the ability to retain and use them most extensively. ''The discovery and appropriation of minerals thus long preceded the settled rights or even the early pretensions of the crown or overlord. Held by the mere fact of possession in the days when might was right, the fundamental ownership and title to minerals gradually became merged in the landlord and the discoverer with varying extent of proprietorship as laws became established''.*

And today we find a more or less complicated system of jurisprudence governing the appropriation and use of minerals in different countries. Recognizing the prime importance to every nation that its mines be worked, and, at the same time, taking cognizance of the fact that mining is an occupation financially hazardous, as it affects the proprietor, and individually perilous, for the miner, in these days when slaves are no longer used and the laborer is admittedly worthy of his hire, all countries provide by statute those regulations which are considered best suited to local conditions and most likely to encourage the industry. Two fundamental principles are common to the mining law of all countries: (1) The right of the mine-holder to a perfectly secure and indefeasible title to his property so long as he fulfills certain specified conditions entirely within his own control, and (2) the right of the state or other landlord to certain rents, royalties or taxes on the property or its output, and to the reasonably constant operation of the mine.

In the power of the government to fix the rate of royalty

* Hoover.

or taxes lies also the ability to promote or to discourage prospecting and mining. If the chief aim of the government is the development of national resources and the increase of general prosperity and business, its policy for the disposition and holding of its mineral lands will be most liberal. If there is a desire to enrich the public treasury directly by means of revenues from taxes upon mines, the result may be a rapid decline of the mining business and a shifting of the population to more favored communities.*

In these days, when our production and consumption of minerals has mounted to towering figures, it has been strongly urged by some that we are prodigal in their expenditure and that the principles of conservation dictate restrictive measures, to the end that there may be something left for future generations. Much alarm has been occasioned in the minds of a certain element of our population by the widely disseminated predictions that our mineral resources are becoming exhausted. The National Conservation Commissions and similar organizations, of this and other countries, have endeavored to form estimates of the supplies of useful minerals known or reasonably supposed to exist within their respective territories; and attempts have even been made to measure the total tonnage of iron ore and coal remaining in the ground in all the lands of the globe.

The results of those mineral censuses have tended to allay the alarm. It has been discovered that although our supplies of coal will not last very long at the constantly increasing rate of consumption which has been maintained for the past half century of tremendous industrial development, yet there is enough in the United States to last us for more than 6000 years at the present rate, and coal fields of unknown size exist in many other little-explored lands.

The blast furnaces of the world seem to possess an appetite that is insatiable, and their size keeps pace with their growing consumption of iron ore. Yet, vastly more ore of commercial grade is being discovered than consumed, and the price, although unstable, tends downward rather than upward. Improvements in the art of recovering metals from various

* Alford, Mining Law, London, 1906, p. 1.

ores are constantly increasing the supply of usable raw materials, and he must be indeed a pessimist who can predict the exhaustion and disappearance of any mineral indispensable to the welfare of the human race.

But even though we may take for granted the sufficiency of the world's store of minerals, the fact of their unequal distribution often gives to one country an advantage over another; and the less favored countries must do their utmost by protective and encouraging legislation to equalize matters, making their abundance in some resources compensate for poverty in others. Herein, and in true appreciation of the importance of mining in industrial economy, lies the opportunity for constructive legislation.

Since the United States, although occupying less than six percent of the continental land area of the globe, and containing a little over six percent of its people, produces, roughly, over one-third of the world's minerals, we should expect to find among its citizens full appreciation of the importance of the mining industry, and on its statute books the best and wisest and most up-to-date provisions for the encouragement and perpetuation of this great industry. It may be of interest, in this connection, to present a few official figures taken from the "Mineral Industry" and the annual report of the Director of the Bureau of Mines:

Output of Principal Minerals of the World and United States.

	Output of World	Output of United States	Per cent of total
Aluminum	78,000*	29,500*	37.0
Cement	200,000,000 barrels	100,000,000 barrels	50.0
Coal and Coke	1,273,000,000*	535,000,000*	42.0
Copper	1,002,284*	557,387*	55.0
Gold	$453,887,000	$88,301,000	17.0
Silver	$147,902,000	$37,920,000	25.0
Pig Iron	63,210,000	24,027,000	38.0
Lead	1,069,289	363,829	34.0
Petroleum	53,293,000*	33,702,000*	63.0
Phosphates	6,290,000*	3,062,000	48.0
Sulphur	1,278,000*	800,300	62.0
Zinc	1,103,000 tons	346,676 tons	31.0
Salt	15,422,000 tons	4,815,902 tons	31.0

* Metric Tons.

The following statement is reproduced with slight changes from the report (No. 694) by the House Committee on Mines and Mining, Sixty-third Congress, second session, submitted May 20, 1914:

> "That the mining industries of the country, and especially the metal-mining industries in our public-land States, are not keeping pace with the normal development of the country is clearly shown by the following data:
>
> "In the population of the public-land States west of the Mississippi and Missouri Rivers there was an increase from 14,800,000 in 1900 to 19,600,000 in 1910, or 32 per cent.
>
> "The agricultural crops of the public-land States had a valuation, in 1900, of $921,000,000, and a valuation in 1910 of $1,950,000,000, an increase of 112 per cent.
>
> "During similar periods the average annual valuation of all the mineral products in the public-land States increased from $287,000,000 during the period of 1901-1905 to an average annual valuation of $358,000,000 during the period from 1906-1910, an increase of less than 25 per cent; whereas the production of the precious metals in the public-land States decreased from an annual average valuation of $136,000,000 during the earlier period (1901-1905) to an average annual valuation of $127,000,000 during the latter period (1906-1910), a decrease of nearly 7 per cent.
>
> "No better illustration could be given of the contrast in the treatment of these two great national industries than the fact that in spite of this lagging behind in the mining industry during this 10-year period, the National Government expended for the reclamation of agricultural lands in these public-land States not only all of the money received from the sale of public lands for agricultural purposes, but also nearly $7,000,000 received from the sale of mineral lands in these States.
>
> "The reduction in the number of men employed in the different metal-mining industries in the public-land States tells even more clearly than do the figures of production

the falling behind of the mining industry. The figures from one of these States may be taken as an example. The average number of men employed in the metal-mining and metallurgical industries in the State of Colorado for the 4-year period, 1900-1903, was 36,189; during the period from 1904-1907 this annual number of men employed was reduced to 34,364; and during the 4-year period from 1908-1911 the number of employees was further reduced to 22,560.

"Among the causes of this lagging of the mine development are the following:

"(a) The approaching exhaustion of many of the more easily discovered and richer ore deposits, and the fact that not enough other rich deposits are being discovered to supply ore to replace that now being extracted; (b) the absence of known methods of profitably working many low-grade ore deposits; (c) the wasteful methods now followed in some mining and metallurgical operations, which, although they may bring temporary profits to mine or furnace operators, are reducing the national wealth in a manner that can be remedied only by the discovery and use of more efficient methods.

"Of a number of our important mineral resources, we have for both the present and future needs of the Nation only an inadequate supply. The utilization of certain of these resources, such as coal, oil, and natural gas, destroys them. Common prudence demands, therefore, that through the necessary researches the Nation should learn how to use this one supply of its mineral resources more wisely and more efficiently.

"The loss of life in the different branches of mining industry is a discredit to the Nation. It calls for more extended inquiries and researches on the part of the Federal Government, and a proper dissemination of the results obtained; it calls for more stringent police supervision or inspection by the State, and for more determined cooperative effort on the part of both the miners and the mine owners in the way of making and enforcing safety regulations.

"The National Government should do its full duty in this matter without further delay. It should lead in a great movement for the practical conservation of life and resources.

"MINING, LIKE AGRICULTURE, WILL BE BENEFITED BY THE LARGER CONTRIBUTIONS FROM THE FEDERAL GOVERNMENT.

"Congress is now appropriating as an aid to agricultural advancement about $28,000,000 per annum. These funds are being expended and the work authorized is being carried forward through a well-organized department with a Cabinet head and with nearly 14,000 employees.

"That these large expenditures have resulted in still larger benefits to the country there can be no doubt, and one of the evidences of the benefits is to be seen in the large increases in the aggregate value of the farm products of the country, which had an estimated value of less than $5,000,000,000 in 1898 and nearly $9,000,000,000 in 1912.

"The conditions underlying agricultural progress differ as to many details from those associated with mining, but the broad general principles of progress are the same, and the favorable response to the national aid for agriculture is itself an evidence of the favorable result that can be depended upon if similar aid is extended to mining. Furthermore, the less extended actual experience growing out of the more limited expenditures through the United States Geological Survey and the Bureau of Mines on behalf of the mining industry furnishes specific evidence of the larger benefits that may be expected to result from larger expenditures for mining investigations. Thus, under the Bureau of Mines, through a small expenditure, the saving in national wealth through stopping the waste of natural gas in one and one-half years has aggregated more than $15,000,000, which is several times the total cost of the maintenance of the Bureau of Mines from its beginning.

"The benefits that may be expected from more liberal aid to the mining industry will come (1) through a better

safeguard of the health and lives of those engaged in mining and metallurgical operations; (2) through the lessening of the unnecessary waste in the mining and treatment of the various mineral products; (3) through increased efficiency in mining operations by the improvement of health and safety conditions; (4) through the development of more efficient and cheaper methods in the treatment of low-grade ore deposits, which are either not now worked at all or worked only in their richer parts or pockets. These benefits may come either through the discovery of new methods in connection with the researches of the Bureau itself or through its activity in stimulating researches by private parties.

"THE COUNTRY'S RELATION TO ITS TWO GREAT FOUNDATION INDUSTRIES, AGRICULTURE AND MINING.

"A brief statement of facts will indicate in a general way what the National Government is doing to aid the development of each of its two great basic industries and what in turn these two industries are contributing yearly to our national wealth and progress. Although the figures are not fully comparable in all respects, they will be found to be essentially correct.

"What these two basic industries do for the Nation:

Item	Agriculture including forestry	Mining and mineral industries*
Number of employees	13,000,000	2,300,000
Yearly value of products	$10,500,000,000	$4,600,000,000
What each worker in these industries contributes to the national wealth yearly	$800	†$1,800
What each industry contributes to the freight tonnage of the country yearly, per cent	22	60

* The scope here includes mining, metallurgical, and other mineral industries, as does the work of the Bureau of Mines.

† Exclusive of the value of the mineral and ores as they occur in the ground.

"What the National Government is doing for each of these industries:

Yearly Appropriation	Agriculture	Mining
For education		
From direct appropriation	$ 2,500,000	Nothing
From land grants	1,030,000	Nothing
From Smith-Lever Act for demonstration educational work	*480,000	Nothing
For 52 experimental stations, one in each State and Territory	2,550,000	Nothing
For general researches and other work to aid agriculture and mining	22,410,000	†$1,967,000
Total	$27,970,000	†$1,967,000
Per capita contribution from the people of the United States for the advancement of these industries	$0.28	$0.02
Of this contribution the per capita expenditure for safeguarding the lives of 2,300,000 employees in the mining industry is about one-half of 1 cent per annum		.005

"Nothing can show the relative national neglect of the mining industry more clearly than does the above tabular statement; and this neglect is all the more difficult to understand in view of the hazards of that industry and the other conditions that should appeal to the humanitarian as well as to the commercial instincts of the American people. But another fact that tells the story with equal emphasis is that during the past 10 years, in addition to the large sums paid out of the National Treasury for the

* $480,000 for 1915; increasing to $4,580,000 for 1925 and each year thereafter.

† Of this amount less than $500,000 is expended under the Bureau of Mines in behalf of improvement of safety and health conditions among the 2,300,000 employees in the mining industry; of the remainder, about $1,300,000 is expended for geology, topography, water powers, and other problems having to do with the commercial side of mining and other industries, under the Geological Survey; and $135,000 is expended under the Bureau of Mines for the commercial testing of the coal and oil used by the Government.

benefit of agriculture, as indicated above, and the payment towards the reclamation of agricultural lands in the Western States of all funds arising from the sale of public lands in those States, even the proceeds of the sale of the Nation's mineral resources in like manner have gone not to aid mining but to the reclamation of additional agricultural lands.

"WHY THE MINING INDUSTRY HAS RECEIVED RELATIVELY SO LITTLE NATIONAL AID.

"Agriculture is much the larger of the two industries; it embraces a larger number of persons, more widely distributed, and each acting as an independent agent. Its products, supplying the country with food, and clothing, bring this industry even closer to the lives of the people than does the mining industry, though the latter supplies them with the fuel that cooks their food, heats and lights their houses (which are built largely of mineral products), operates and supplies a large share of the materials and all the machinery of their factories, conducts and operates largely their facilities for transportation and communication, and supplies more than 60 per cent of the total freight tonnage of the country. Indeed, the mining industry is in large measure the real basis of our modern civilization and national life.

"But, more than the above, there must be some special reasons why the mining industry has received relatively so little aid from the National Government, and these are to be found, no doubt, in certain misapprehensions concerning the industry. Mining is usually regarded as an industry comprising the operation of a few large, highly profitable properties, such as the old Comstock mines in Nevada, the Treadwell mine in Alaska, or the Homestake mine in South Dakota. It is usually considered to be an industry controlled by a few parties, the owners of the large properties mentioned, who would gladly avail themselves of an opportunity to unload on the National Government the cost of conducting those researches in which they are particularly interested. Therefore, it is usually considered as an indus-

try that should be allowed, and even required, to take care of itself. These assumptions are far from correct.

"The facts of the situation are:

"(1) These large, highly profitable properties are few in number, and, so far as known, their owners have never joined in a request for Government appropriation to aid in the mining industry, nor have they been given any special consideration either in the establishment or in the plans of the Bureau of Mines. These mine owners have neither asked for assistance nor have they endeavored to unload upon the Government any investigations of their own. On the contrary, at the request of the Bureau of Mines, a number of them have expended considerable sums from their own funds for investigations that promise to be useful not only to them, but to other less important mining developments in which they are, and were, in no way interested.

"(2) Although the number of large mines is small, there is a large number of small mines. The records show that in the country as a whole there are about 40,000 coal mines, metal mines, and quarries and about 170,000 oil wells that are operating on a smaller or larger scale. In addition there are many plants for treating ore by mechanical concentration, smelting, or other processes and various mineral-industry plants in different parts of the country. Few seem to appreciate the importance of helping those who hold these small properties to find methods of operation by which the properties can be worked at a profit instead of being helplessly transferred to a few large corporations which alone may have the funds for developing the processes that will make profitable operation possible.

"(3) The most urgent appeal for larger national aid to the mining industry comes from and on behalf of the 2,300,000 employees of the different branches of the industry, who are asking the aid of the Government in the development of safer and more healthful working conditions. This humanitarian appeal should be given precedence over calls for appropriations to advance commercial gains. It comes from employees working under hazardous condi-

tions, a majority of whom are unfamiliar with our language, our laws, or our institutions. These men have been led to believe that the Government of the United States is interested in their welfare and has been planning to aid in bringing about safer and healthier conditions for them; but, owing to long delays and slow progress in the Government's work, they are now becoming discouraged in their belief that such plans would be realized.

"(4) Another important end to be sought through these larger contributions to the aid of the mining industry is helping the consumers or users of mineral products, who are distributed throughout every part of the country. Mineral products are becoming more and more indispensable to the domestic life of the people and to our manufacturers, as well as being the basis of transportation facilities and of the products to be transferred. Under normal conditions, as our mines become deeper and our mineral resources are depleted, not only the hazards of production but also the per capita cost of mineral products is increasing and one important purpose of the larger investigations proposed in behalf of the mining industry is to find how the cost to each consumer may be kept down to a minimum.

"SOME SPECIAL REASONS WHY MINING SHOULD RECEIVE LARGER NATIONAL AID.

"Some special reasons why mining should receive larger national aid are enumerated below:

"(1) Agricultural products, if ordinary care is given to our soils, will be supplied continuously by annual crops. But as regards mineral resources the case is different. Our mines can produce only the one available supply; this one supply must meet the future as well as the present needs of the Nation; and a century's experience has clearly shown that our use of the more important of these resources, such as mineral fuels, precious and other metals, and potash and phosphate deposits, will increase much more rapidly than will our population.

"(2) Although certain of our mineral resources, such as the metals, are destroyed rather slowly in use, other essential resources, such as coal, oil, and natural gas, are consumed or destroyed beyond recovery.

"(3) In the utilization of certain of our mineral resources, such as natural gas, petroleum, coal, zinc, and some of our other metals, there are large losses or wastes that are believed to be unnecessary, and it is a wise duty of the National Government to aid in the prevention of such wastes. These wastes now exceed $1,000,000 per day.

"(4) And more important than all the above in their appeals for the larger aid of the Federal Government are the hazards of the mining industry—the accidents that yearly result in such large losses of life and the unfavorable health conditions in many mines and metallurgical plants which affect adversely the vitality of employees. None of these conditions is encountered in agriculture, but they are all in a peculiar way characteristic of the mining industry; and these conditions alone more than justify additional expenditures from the Federal Treasury".

Still another reason why federal aid should be extended to the mining industry is found in the fact that few countries are independent and self sufficing in their production of minerals and ores. This fact is brought prominently to the front at the present time, by the interruption to the world's commerce occasioned by war. In speaking of this situation, the Director of the United States Geological Survey uses the following language:

"I believe the mineral wealth of the United States is in largest measure the foundation of the marvelous growth of the last few decades. Industrial America! Think to what a degree the industries of America are based upon our ores and mineral fuels, or figure if you will the percentage of railroad tonnage that originates at the mine.

"Not only is our country a world-leader in the output of such essential minerals as coal, petroleum, copper, zinc, iron, lead, phosphate—and in three of these it exceeds all other countries put together—but as far as such things can be measured or estimated we are blest in the possession of the largest reserves of many of the more important of these

minerals. No other country can in any sense compare with the United States in the degree of industrial independence afforded by the possession of these mineral resources. The raw material is at hand to enable us to win and maintain supremacy as a manufacturing nation.

''Yet, under this most-favored nation clause, the catalogue of our mineral resources is not the complete list of minerals essential to modern civilization; a few items are missing, others are present apparently only in insufficient quantities, and the quality or locality of the deposits of still other minerals may be unfavorable to present-day utilization. Thus it happens that the nation is not wholly independent in its mineral industry. The list of what we lack is short. We are wholly dependent on other countries for only four principal items—tin and nickel, potash and nitrate. Among the minerals of which the United States has a deficient supply are manganese, platinum, gems and asbestos. Still other minerals it has been more profitable to buy abroad than at home, such as chrome ore, barytes, flint pebbles, magnesite, mica and graphite. * * *

''This is a good time to drop any ideas we may have of industrial superiority and to copy for a while the industrial spirit of Germany, which systematized processes and standardized products until they won markets in every continent by sheer superiority''.

If it is then important for the people and government of the United States to aid and encourage the development of its own mineral resources, how much more important should such efforts be for those nations which have not the generous provisions of nature in the shape of easily won mineral deposits. Nor is it alone the federal government which should evince an interest in the working of mines. Every state and every province should do its share, and instead of looking upon mines as something to be taxed to the very limit or beyond, should feel that it is of intimate and vital importance to every citizen of the state or province that its mines and quarries be worked to the highest stage of productivity of which they are capable. Far greater than the value of the taxes paid into the state treasury

is the benefit derived indirectly from great institutions for the production and working of minerals; and the steady operation of mines and metallurgical plants in a community is of incalculably greater importance than the derivation of direct revenues to enrich and often debauch the public treasury. For concrete examples of the truth of this statement look at Chile with its nitrate deposits paying millions yearly to the government and then turn to Sweden and observe its wise policy of encouragement of the development of its iron mines. The former country has not only not aided in the nitrate industry, but has done its best to turn it into cash for the government treasury, much to the disadvantage of public morals; the latter country has given its lands freely, has appropriated large sums for railroads and for other necessities to those who would develop an industry which would afford permanent employment to large numbers of laborers.

Full discussion of this subject would involve consideration of the bearing of mineral production on all lines of industry: it would necessitate a study of modern civilization and industrial development in all lands. For those who are already students of the subject, such elaboration is superfluous; to those who are not, it would be tiresome and unread. Enough has been said to indicate its importance. In conclusion, the following propositions may be taken as established beyond question:

1. From the dawn of civilization to the present time national standing has been dependent on and conditioned by mineral wealth and consumption.

2. Next to agriculture, no industry so deserves the sympathy and aid of governments.

3. The attention of legislators, both state and federal, should not only be invited but compelled to the necessity for wise and sympathetic legislation in connection with the mining industry.

4. It is incumbent on every engineer and mining man, and indeed upon every citizen to insist that our mining laws shall be most carefully framed so as best to promote the interests of the mining industry, and hence of every industry throughout the entire length and breadth of the land.

Paper No. 163

MINE INSPECTION.

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INTRODUCTION.

Inspection of a mine has for its purpose the observation of the physical condition of the mine to determine its relative degree of safety for the health, life and limb of the underground workman, and for the preservation and conservation of the property.

To go beyond the work of an inspector and indulge in examinations which have for their purpose the development of safer methods of mining, the recovery of the maximum percentage of the mineral, the study of conditions affecting health and sanitation, the relative safety of the use of different explosives, involves rather the work of the Mine Investigator who must necessarily have greater technical training than the Mine Inspector. In the main, this paper treats of coal mine inspection, while a summary of the metal mining laws only is given.

As the basis for a more thorough discussion of this subject than is contained in this paper there is presented below a topical outline of the component parts under which the subject matter could to advantage be treated.

MINE INSPECTION.

The purposes of inspection.

Inspection—

1. By the state and government:
    - (a) To secure compliance with specific legislation in the performance of leasehold agreements.
    - (b) To conserve life, health and property.

(c) To conserve natural resources.
(d) To compile statistics.
(e) To recommend additional legislation for the correction of manifest evils.

2. For purposes of insurance:
   (a) To determine fire hazard.
   (b) To determine subsidence liability.
   (c) To determine liability of water inflow.
   (d) To safeguard the employes.
   (e) To classify risks.
3. Company inspection:
   (a) To obtain efficient management.
   (b) To obtain maximum recovery.
   (c) To secure safety to employes.
   (d) To secure economic operation.
   (e) To meet the requirements of laws.

With the advent of compensation laws which admit of a classification of mine hazards based upon a study of local conditions at each mine, the field of mine insurance will be greatly enlarged, and we may look for better conditions to prevail in the mines.

Where a uniform flat rate is made to apply to all mines with no concessions in premium for safety precautions installed, there will be lacking an incentive to improve the safety conditions, and there will be no rivalry among insurance companies to assume the risk except at exorbitant rates.

A compensation law which calls for a sliding scale of premium rates, determined by local conditions, will be a great help to the State Mine Inspectors. Indeed it may not be long before the work of the State Inspectors and the compensation boards or commissions will be coördinated and the inspection work be placed under the supervision of the compensation boards.

Such an arrangement would not necessarily disarrange the present organization of the State Inspection service.

Few operators have, of their own volition, established a system of inspection in the absence of some law calling for specific performance of certain duties. The existence of inspection laws is the outcome of intolerant practices on the part of the master toward his servant who has no voice in the management of the operations which utilize his labor.

Inspection laws have been the result of disasters involving loss of life under conditions wherein the operator, the miner and the state had failed to foresee or recognize certain dangerous conditions under which men were permitted or obliged to work.

To the layman, inexperienced in mining, there is an unwarranted feeling of horror for the vocation of the miner. This feeling has often crystallized in legislation, some of which has been beneficial to the industry and mankind, and some of which has been a detriment to the industry and of no benefit to the miner.

In general, the purpose of all inspection laws is to enforce compliance with some specific requirement or regulation.

GOVERNMENT VS. STATE REGULATION.

Governments legislate to accomplish a specific purpose and leave the execution to executives who formulate the regulations under which the laws are operative. This applies in Kingdoms and Republics. In states having a democratic form of government the legislation is specific and the machinery for its execution is detailed in the legislative act. The regulations governing the execution of such laws are controlled by the code of laws respecting police regulation, and the authority of the executive is circumscribed by inhibition of court decisions based on common and statutory laws.

A full measure of the execution of statutory law has its limitations, whereas organic acts of governments admit of wide latitude in the interpretation of what constitutes full compliance. This condition admits statutory law being followed only in its specific injunctions as sustained by court proceedings, and organic laws being followed by rules and regulations promulgated in accordance with legal practice based upon the judgment of the executive.

In the one case we have the judgment of a legislative authority for the accomplishment of a purpose restricted to mandates of law, and on the other we have legislative authority based on the judgment of specially qualified executive officers

whose judgment is given favorable consideration by the courts of authority.

GOVERNMENT INSPECTION.

The Government of the United States, outside of Alaska, does not maintain an inspection service in the mining industry in a manner similar to the states. Such inspection as is made by the government is conducted by specially qualified engineers in looking into the compliance of certain leasehold contracts made with the government on behalf of public mineral lands, including coal, oil and natural gas, or on behalf of Indian tribes, which are wards of the nation.

Only in recent years, the government has incorporated in some of its leases regulations governing safety in operation and provided for engineers who look after the details of the lease contract in respect to safety, sanitation and methods of mining.

In the state of Oklahoma, the Government has the authority to promulgate regulations for safety in mining on the Indian lands. Such mines as are located on the Indian lands are also subject to inspection under the state Inspection laws.

The only mine inspection service now conducted under police laws of the government is in Alaska.

Under an act of Congress the metal and coal mines of Alaska are inspected by Government Mine Inspectors who report to the Department of the Interior through the Bureau of Mines.

STATE INSPECTION.

Work of the State Inspector.

The work of the inspector in the various states is similar in many respects.

The subject requiring most time pertains to ventilation. Next in order is that of roof support and timbering. The use of explosives and the prevalence of dust are gradually receiving much merited attention by all Inspectors.

The large use of electricity and machinery in mines has added much to the work of the Inspectors.

Formerly much stress was given to drainage. This, however, was when mines were shallow or near the surface and the men often worked all day standing in water. The wet mine is now exceptional and we hear of the dry and dusty mine. In addition to the routine work of inspection the inspector must write a report on each mine visited and investigate all fatal accidents. In states not having compensation laws and where suits for damage are prolific, the inspector is compelled to spend much valuable time in court.

Selection of State Inspectors.

The selection of state inspectors in a large majority of states is governed by politics. Indeed, no state is free from the influence of political preferment in the selection of the inspectors.

When the politics of the head of the state government is known it is safe to infer that the majority, if not all, of the inspectors belong to the same political faith. Pennsylvania is the least subject to this general practice. In this state the Inspectors for the bituminous mines are strictly under a civil service and are appointed from a roster of eligibles who have qualified by an examination conducted by a board of examiners.

In the anthracite districts the inspectors are elected by a vote of the people. The candidate, however, must be certified by the examining board as being properly qualified. Up to the present time no candidate has had political opposition on any of the election ballots. The Examining boards have certified only sufficient eligibles to fill the vacancies.

In the state of Oklahoma the inspectors are elected by popular vote. In all other states the inspectors are appointed either by the Governor or by some political board or commission.

In a few states the Chief Inspector is authorized to nominate, and in some instances appoint, the district or deputy inspectors. In a number of states the candidates for appointment are required to have a certificate of eligibility issued by an examining board.

Coal Mining States: Men, Mines and Inspectors.

(Abstracted from U. S. Bureau of Mines Bulletin 115)

	Number of men employed 1913	Number of mines 1913	Per cent of coal shot off solid 1913	Inspectors			
				Chief or state	Assistant or deputy	District inspector	Total
Alabama	24,552	224	39.9	1	6		7
Alaska and California	40	3	95.2	....	....	....	....
Arkansas	4,652	53	79.5	1	....	....	1
Colorado	11,990	171	13.9	1	3	....	4
Georgia	500	2	100.00	....	....	....	....
Idaho and Nevada	12	3	....	....	....	....	....
Illinois	79,529	526	33.2	....	....	12	12
Indiana	22,235	231	30.1	1	5	....	6
Iowa	15,757	203	72.3	....	....	3	3
Kansas	12,479	152	80.5	1	5	....	6
Kentucky	26,332	331	15.7	1	5	....	6
Maryland	5,645	67	6.2	1	....	....	1
Michigan	3,305	26	29.5	1	....	....	1
Missouri	10,418	208	46.8	1	....	2	3
Montana	3,630	43	35.3	1	....	....	1
New Mexico	4,329	36	17.6	1	....	....	1
North Dakota	641	55	26.3	1	....	....	1
Ohio	45,815	667	3.7	1	12	....	13
Oklahoma	9,044	95	80.9	1	....	3	4
Oregon	203	7	....	....	....	....	....
Pennsylvania (anth.)	175,644	278	....	1	....	21	21
Pennsylvania (bitum.)	172,196	1,503	2.6		....	27	28
Tennessee	11,263	134	37.	1	....	2	3
Texas	5,101	47	25.2	1	....	....	1
Utah	4,158	27	4.6	1	....	....	1
Virginia	9,162	60	32.6	1	....	....	1
Washington	5,794	53	37.8	1	....	....	1
West Virginia	74,786	788	.8	1	....	15	16
Wyoming	8,331	61	36.7	....	....	2	2
Total	747,644	6,054	....				

General Review of Mine Inspection Laws of the States.

A review of the mine laws of 24 states reveals a lack of uniformity governing many conditions which are common in mining.

With few exceptions the inspection laws of the states apply to mines employing ten or more men in a period of 24 hours. The salaries of chief inspectors range from $1800 to $4000 per year and of the assistant or deputy inspectors from $1200 to $3000.

In ten states the chief or deputy inspectors are authorized to close a mine for violation of law which endangers the lives of the workmen. In six states the inspector may apply to the courts for an injunction to restrain the operation of a mine.

In five states the mining law is vague or lacking in methods of procedure for closing a mine.

In one state the method of procedure calls for joint inspection by the district or deputy inspectors and by a commission appointed by the court.

In addition to being required to see that the provisions of the law are carried out, in 12 states the inspectors are given the authority to forbid dangerous practices, not specified by law, while in one state the law specifies that the inspector shall not require anything beyond the stipulations of the law.

In eight states the operator is authorized to adopt rules for the operation of his mine and in four other states he is authorized to adopt a code of signals.

In nine states no provision is made by law requiring the presence of stretchers or first aid material.

Five states have legislation relating to mine rescue apparatus, stations or cars.

Thirteen states make no provision for fire protection at or within the mines.

Only two states have specific laws which classify mines as gaseous or non-gaseous.

In one state a mine is considered gaseous if explosive gas is detected on the flame of an approved safety lamp. This means that one percent of gas would class the mine as gassy.

In another state the classification is made for dusty and

non-dusty mines. In the former ¾% and in the latter 1¾% methane places the mine in the gaseous class.

In only one state does the law say that shooting on the solid is unlawful.

Twelve states have no law covering shooting on the solid, while seven states have laws for regulating solid shooting.

Three states have no laws applying to explosives. All others have laws on the subject, but in the majority of these states the law applies to the handling and storing of powder and specifying the quantity each miner may have in his possession at any one time. This ranges from 5 to 25 pounds up to one day's supply with no limit as to quantity.

Eight state laws mention the subject of electricity. The provisions range from the mere statement of "use care in its use" to a complete code of laws on its installation and use.

Concerning the danger of coal dust, there are eleven state laws which have no provision covering the subject. The following is the substance of the requirements of the states which cover the subject: "keep the dust sprayed", "neutralize the dust by wetting or use stone dust", "sprinkle roadings", "sprinkle or remove the dust", "Keep the dust damp", "use water or chemicals", "sprinkle entries or air ways", "Wet all parts within 80 feet of the shot", "Remove dust and properly water down", "Inspector shall prescribe the necessary precautions", "Remove the dust and keep all parts of the mine saturated with water or use other means to render the dust non-explosive".

In the matter of shaft signalling, there is much uniformity in the different laws. "Metal speaking tubes and other usual methods" are required by the majority of the laws. In ten states the telephone is an additional requirement for communication, some requiring telephone stations at certain places throughout the mine.

In thirteen states no code of signals is prescribed by law, while ten states prescribe codes which are not uniform.

The laws of six states do not call for the employment of a fire boss. All others do, altho he is called gas boss in one state and agent in two states.

Thirteen states have no law calling for the display of danger signs. One state calls for danger signs and fences. The remaining states call for either a danger sign or some evidence of the presence of the fire boss.

Safety in hoisting is covered by the laws of practically all the states, but there is lack of uniformity in the requirements. In six states there is no provision for regular inspection of the ropes and hoisting machinery.

No state law deals with the conservation of coal or the plan of operation of the mines. In a few states the method of extracting the coal at the face together with plans for ventilation is laid down in the law.

Shot fires are provided by the laws of ten states, three of which apply only to gaseous mines.

In eleven states no requirement of law applies to stairs, ladders and landings in escape shafts.

Nine states require stairs and landings; one, stairs or ladders and landings, and one calls for stairs.

In three states the laws require the presence of sign boards which indicate the direction to follow to reach escape ways and shafts.

DEFICIENCIES IN COAL MINE LAWS.

In many states little or no specific law has been enacted covering the subjects listed below. In a few states some of these subjects have been covered by laws. Pennsylvania has the most elaborate law relating to electricity.

1. Classification of gaseous and non-gaseous mines
2. Storing and handling of explosives
3. Use of explosives at the face
4. Methods of shot firing
5. Taking care of coal dust
6. Electricity installations
7. Use of electricity in gaseous mines
8. Use of gasoline and volatile oils
9. Danger signs and fences
10. Safe escape ways

Summary of Inspection Service in the Metal Mining States.

State	Date of first state inspection laws	Date first inspector was appointed	Amount of annual appropriations	Amount expended in 1911	Date of passage of present law	No. of inspectors	Manner of selecting inspectors	Manner of selecting deputies	Term of office of inspector	Term of office of deputies	Annual salary of inspector	Annual salary of deputies	Traveling expenses allowed	No. times each mine required to be visited yearly	Approx. av. No. times each mine is actually visited yearly	No. mines and quarries to be inspected	Number of men employed	Approx. cost of inspection of each mine	Approx. cost per employee
Arizona	1912	1912	$10,8[illegible]	$12,571	1912	1	Elected	Appointed by inspector	2	2	$3,000	$[illegible]860	$1,400 each	Once; four if employs over 50 men	3	84	13,953	$150	$0.90
Colorado	1889	1889	12,500	17,800	1911	5	Appointed by governor; title of commissioner	Appointed by commissioner	4	2 Assigned districts title of inspector	3,000	1,800	1,000 Commiss'r 1,200 Inspector	1	[illegible]	737	24,500	24	70
Idaho	1889	1889	3,000	[illegible]	1899 as amended since	1	Elected				2,400		900	1	1	50	6,200	100	.80
Michigan (state)	1887			20,200 (est.)	1911	13	Elected	Appointed by inspector	2	Option of inspector			[illegible]c per mile	6		241	34,133	84	60
Baraga County	1887			250	1911	1	"		2		250		" " "	6	12	6	Est. 1[illegible]		
Dickinson County	1887	1887	1,400	1,800 and exp	1911	1	"		2		1,800		" " "	6	12	16	2,700		
Gogebic County	1887	1887		3,[illegible]0	1911	2	"	" " "	2	"	$5 p. d.	$3½ p. d.	" " "	6	6 or more	26	5,256		
Houghton County	1887	1889		4,350 and exp	1911	3	"	" " "	2	"	1,800	"	" " "	6	12	73 (Shafts)	14,000		
Iron County	1887	1890	400	5,000	1911	3	"	" " "	2	"	2,400	"	" " "	6	12 (est.)	56	3,667		
Keweenaw County	1887	1887	100	1,700 and exp	1911	1	"		2		1,700		" " "	6	12 (est.)	4	2,500		
Marquette County	1887	1887		[illegible] 350	1911	1	"		2		2,000		" " "	6	12 (est.)	49	2,060		
Ontanogan County	1887			800 and exp.	1911	1	"		2		800		" " "	6	6 (est.)	11	700		
Minnesota (state)	1905			5,2[illegible]0 (est.)	1905	3	Elected		3							1[illegible]5	20,045	34	26
Crow Wing County	1905			1,000 and exp.	1905	1	"		3		1,000				6 or more as necessary	16	1,400		
Itasca County	1905	1905		1,200 and exp	1905	1	"		3		1,200				4	20	2,600		
St. Louis County	1905			2,600	1905	1	"		3		2,000		600		2+	119	16,045		
Missouri	1887	188[illegible]		11,920 (est.)	1899	5	Appointed by governor	App. by chief inspector	4		2,000	1,800	1,200		24 to 48	650 (Coal [illegible])	20,000	24	.6[illegible]
Montana	1888	1889	1,800	6,000	19[illegible]	2	Appointed by governor	Appointed by governor	4	4	2,500	2,400		1	3 (more important)	35[illegible]	15,500	17	.39
Nevada	1909	1909	9,000	9,000	1911		Elected	By inspector	4	4	3,600	2,400			1 or more	1[illegible]0	5,000	21	1.90
New York	1890	1893	[illegible]	2,400	1911	1	Civil Service	Indefinite			1,800		Act. exp.		1 or more	(a)	(b)	161	.40
South Dakota	1893			2,350		1					1,000		10c mile	1	4	45	2,800	52	.84

(a) 45 mines, 2[illegible]0 quarries which do not operate in winter. (b) 3344 in mines, 5156 quarries.

11. Man trips
12. Underground telephones
13. Retiring and refuge chambers
14. Inspection of hoisting machinery and ropes
15. Emergency hospitals and first aid stations
16. Overwinding devices
17. Systematic timbering
18. Protection against fire
19. Sanitation
20. Wash and change houses
21. Method of mining
22. Conservation of mineral
23. Accurate maps
24. Subsidence of overlying strata
25. Encroachment on adjacent lands
26. Code of signals for hoisting
27. Safety rules
28. Boiler inspection

Insurance.

A form of insurance, as it applies to mining, patterned after the fire risk for real estate, had been given little attention in the United States.

The risks assumed by indemnity insurance companies have in large measure been written on a flat rate basis, but in some instances there has been an effort made to classify the risk and adjust the rate to suit the apparent hazard.

With the advent of compensation laws there appears to be a wide field for the exploitation of indemnity policies based upon liability, classified according to the risk assumed. Such laws as conform to a liability compensation will open a field of beneficial indemnity insurance based upon a classification of risks and a sliding scale of rates, that will be beneficial to the mining industry in the reduction of accidents.

There is not a State law in the United States for the prevention of mine explosions based upon scientific principles as the result of experiment. There is not a State law, based upon practical experience, which applies to systematic timbering.

Many operators and inspectors have brought about systematic timbering, much to the relief of the miner.

Insurance Inspection.

In the inspection of coal mines for insurance purposes, the inspector must go beyond the requirements of the State laws as they pertain to safety precautions, and assume a large responsibility in the exercise of his personal judgment. The State laws are specific in their requirements and the State inspector has fulfilled his duty when he confines his attention to their enforcement, and recommends additional laws based upon his personal judgment.

On the other hand, an inspector for classifying hazards for insurance purposes must be governed by his knowledge of conditions within mines and the most approved methods for reducing accidents, whether required by State laws or not.

Liability to Property Interests.

Another feature not heretofore covered by insurance is the loss to property due to explosions and mine fires. Many mines have exploded and many fires have occurred without the loss of life or personal injury. In some cases the property loss has been great and made more expensive through enforced idleness of the mine.

MINE FIRE INSURANCE.

Most hazards above ground are covered by some classified insurance risk, but underground hazards, such as are embraced in mines, have not been covered by any insurance risks other than liability as the result of certain hazards.

There are two hazards in mining not now insurable under any table of classified risks, namely, the hazard of fire and the destruction resulting from mine explosions.

Mine Fires.

In coal mines fires are not numerous considering the large number of mines in daily operation and the combustibility of much material in the mines. In metal mines the liability of fire is much greater, especially in certain ore deposits and in mines using large quantities of timber.

Occasionally fires in mines result in property loss and enforce a suspension of operation in part and sometimes the whole of a mine.

Many incipient fires are of daily occurrence in mines in certain localities but are quickly extinguished by fire runners, and their occurrence is given little or no publicity.

The causes of the fires are due wholly to the methods of mining and lack of precaution, and consequently come within the province of insurable risks, since most physical conditions resulting from the industrial efforts of man have hazards which are capable of being classified under an insurance risk.

Like frame structures in congested parts of cities, which have been free from the ravages of fire for many years, we have mines which for many years have been free from fires. On the majority of the former, insurance has been constantly carried, while on the latter no insurance has been carried.

A frame structure on the surface might be immune from the danger of fire were it not for the presence of man and the uncertainty of lightning. Aside from Providential acts, fire risks are written upon the careless acts of man.

Operators of coal mines in the various states prosecute the work of mining by virtue of authority of the state vested in charter rights, copartnership or individual rights, made secure from destruction or attack by the laws covering property rights and license to conduct business, the state reserving the right to exercise police jurisdiction and to establish an excise tax on the privilege of conducting the business as well as to exact a taxation upon the land, improvements, production and gross or net revenue.

The state prescribes the manner in which the work may be conducted for the safety of the employes, requires the operator to employ specially qualified men to look after the execution of these safety requirements, and a state inspection service to ascertain wherein the laws are not complied with. When the operator has met the full requirements of the law and has become a party to a compensation law, why not extend to him the same protection as is accorded property owners in cities and congested communities?

LIABILITY INSURANCE.

A form of insurance known as "Liability" has occupied a prominent place in most of the mining states. This character of insurance is giving way to a form of compensation insurance in many of the states as it pertains to organized industries.

Prior to the adoption of compensation laws, liability insurance was much in evidence in the mining industry. The percentage of the volume of business was based largely upon the history of the court proceedings in damage cases for injury and death.

In the conduct of the business of the companies engaged in writing liability insurance, much dependence was placed on the published reports of the State Inspectors in classifying the risk. However, in recent years the larger of the companies appoint inspectors who visit and report upon prospective risks and who make inspections at intervals after the policy has been written.

In some States the operators have formed relief associations and in making assessments the services of special inspectors have been engaged, whose duty it is to inspect the mines and see that the code of safety standards is being complied with, and in the event of an injury or fatality, to secure the facts which would be the basis for a monetary settlement for liability or for defense in court proceedings.

The inspectors for the insurance companies and relief associations conduct their work in a manner similar to the state inspectors. They go through the mines and note the conditions as they affect safety and make their report upon blank forms and supplement these by a descriptive report. In the conduct of their work they follow the requirements of the State law as it applies to safe conditions and draw upon their own experience and observation for determining other safe conditions and practices. From each observation the inspector is expected to determine whether the mine is a good, fair or bad risk.

The personal equation of the inspector is a factor hard to eliminate when he is required to commit himself on theoretical dangers, and this frequently occurs in the case of dry, dusty

coal mines where the improper use of explosives in the absence of the inspector may destroy all life within the mine.

A more satisfactory system would involve a classification of the mines based upon a schedule of inspection which calls for certain credits and debits.

Liability for damages as the result of accidents has been a potent factor in framing much of the mine legislation in the states. Where specific performance was required, involving the act of an employe, the operator sought to be relieved of responsibility, and on the other side the miner sought the right to sue for damages for neglect of the operator or of a fellow servant.

This contest between the master and the servant is gradually being eliminated through the adoption of compensation laws whereby the state assumes the responsibility of paying stipulated amounts for injuries and death.

In those states which have compensation laws, we may look for the adoption of many safety regulations, voluntarily by some and through legislation by others. The inspectors in these states should have little difficulty in securing much detailed legislation which would insure greater safety in mining and a corresponding reduction in accidents.

Dangerous Practices in Mines.

In a number of states the Inspectors are required by law to see that the provisions of the law are strictly observed and to prevent all dangerous practices. This is very good for the inspector when the dangerous practice is such as is apparent to any observer; but there are a number of practices indulged in by miners and operators about which there are doubts in the minds of the inspector, the operator and the miner, whether they are real dangers. All goes well until one or more of these practices is the cause of an accident, involving large loss of life, and immediately the inspector is censured as being incompetent, or for failure to perform his duty.

In view of there being a number of dangerous practices upon which, as yet, we do not have the benefit of scientific experiment, the inspector is placed at a great disadvantage in ruling against or in favor of certain practices.

There is much an inspector could do to prevent coal dust explosions if he had the authority to make certain rulings and the means of enforcing their adoption.

None of the mine laws of any of the states deals with coal dust as a source of danger, based upon scientific study or experiment.

Many laws say that coal dust in dangerous quantity should not be allowed to accumulate within certain parts of the mine; others that the coal dust on roadways shall be sprinkled, and one state requires the use of water or stone dust to neutralize the coal dust.

COMPANY INSPECTION.

With a view of securing greater safety as a first consideration, with economy in operation, a number of large corporations have organized an inspection service. The verdict of all such companies is that the service has been most satisfactory both in the reduction of the ratio of accidents and in a real economy in the operation of the mine.

To secure information upon the operation of the inspection service of operating companies, a letter was addressed to several of the companies which were known to have inaugurated a safety propaganda.

The following inquiry was made:

> It is not generally known the extent to which some of the operating companies have engaged in private mine inspection, and the information you furnish will be used in such manner as will bring forward the activity of mine operators with a view of increasing safety conditions.
>
> Information on the following points is desired:
>
> 1. Date of inauguration of inspection service
> 2. Outline of the organization
> 3. Power and authority vested in the inspectors
> 4. Some of the benefits derived
>   (a) from point of safety
>   (b) from point of economy.

To the above inquiry a number of replies were received. The value of some of these can be appreciated only by reading them, and the writer takes the liberty of presenting the text of a number of them.

H. C. Frick Coke Company
Operating Mines in Western Pennsylvania.

The H. C. Frick Coke Company has ever been anxious to promote the safety of its employees. In the history of its operations this feature has always been the most prominent; the regulations looking to the attainment of safety have ever been clear and emphatic, and the enforcement of them most strongly impressed on officials and workmen.

To increase the safety of persons employed underground, a Mine Inspector, one who had been in the service of the State for twelve years, was appointed in April, 1890.

About this time the General Manager issued instructions that neither time, labor, nor expense should be spared to guard against accident, and that mine officials should always keep this fact prominently in mind that it was the desire of the Company, and their duty as well, to make the safety of the lives of employees their first and important business.

In this spirit, mine inspection was continued either by individual officials or appointed committees, until 1904, in which year two regular Inspectors were appointed and the mines divided into two districts. In 1908 a third Inspector was appointed and the mines divided into three districts. All these Inspectors had orders to look for dangers of all kinds and had full authority to order immediate attention to any danger discovered and the removal of it as soon as practicable.

In 1912 a Chief Inspector was appointed, whose duty was to supervise the reports of the District Inspectors, and to advise with them when necessary and particularly to personally examine into the cause of fatal and serious accidents occurring in the operation of the mines, make a survey of the place, to sketch the surrounding conditions and make such suggestions to the General Superintendent and local officials as would tend to prevent repetition. A print of the survey and sketch, together with the suggestions made, is then sent to all of the operators for their information and discussion in order that they may guard against like accidents.

This was supplemented by lectures given by the Chief Inspector of Mines on "Timbering", "Methods of Testing Roof", and "Safe-guarding Workmen Engaged in Transportation",—in a word, on the "Causes of Accidents and How to Avoid Them". These lectures were attended by officials and workmen. Last of all, several hundred photographs were taken in the mines by the Chief Inspector, the purpose being to illustrate the conditions under which accidents happened and how they could be avoided. These were first shown and explained by a competent lecturer

to everybody living around the mines, and afterwards in many other towns and mining settlements. Half-tones of the photographs were made and assembled in pamphlet form, under the title of ''Safety First'', a simple legend explaining the purpose of the picture being placed under each half-tone. These pamphlets, printed in several languages, were distributed among the workmen, a copy being given each employee.

Another very important feature of mine inspection is that by Committees of Workmen. The inspections are made three or four times yearly, from one to three days being required, depending upon the extent of the mine workings. The workmen are paid their usual wages during the time required to make the inspection. Free and full criticism is invited and given. Officials are required to give them every facility to make a thorough inspection and when an adverse report is made, the local management must acquiesce. These reports are made to the Superintendent of the mine inspected, who must send the original to the General Superintendent, who gives orders to the Superintendent of the mine to have the matters complained of made right in the shortest practicable time. The inspection committee is usually made up of a miner, a driver and a tracklayer or timberman. Where mining machines are used, a machine runner is sometimes substituted for the tracklayer or timberman. Outside inspections are made in like manner by outside Committees.

The Company has found this method of inspection to be very satisfactory, and the workmen, at the same time, appreciate the confidence reposed in their ability to assist in passing upon conditions that otherwise might jeopardize their safety.

The chief benefits from the standpoint of safety which have been derived from Mine Inspection are shown in the following table:

Years	Tons Mined per Death Underground	Deaths per 1000 Employees Underground	Deaths per Million Tons Mined Underground
1907	359,458	4.65	2.78
1908	306,503	3.52	3.27
1909	333,560	4.01	3.00
1910	552,253	3.20	1.80
1911	651,888	2.27	1.53
1912	563,530	2.80	1.77
1913	502,695	3.44	1.98
1914	977,000	1.46	1.02

Systematic and thorough Mine Inspection has resulted in considerable economy in the operations of the Company. New methods of work have resulted in better ventilation and extraction of coal, which, with concentration of work, with the development and adoption of better supervision, have resulted profitably and have raised the standard of mining throughout the Region.

Tennessee Coal, Iron & Railroad Company
Operating Mines in Alabama.

1. Date of inauguration of inspection service.
While there have always been inspections of coal mines with reference to safety conditions, a more thorough system was organized early in 1910 when a Chief Mine Inspector was appointed to devote his whole time to safety conditions in and about the mines.
2. Outline the organization.
The Chief Mine Inspector covers all mines at stated intervals, visiting every work place in the mine; makes recommendations covering safety conditions, and impresses on the men the necessity of living up to the rules and regulations of the mine. In addition to the Chief Mine Inspector, each mine has one or two safety inspectors, according to the size of the mine, who devote their whole time to the inspection of the working places and the condition of machinery and safety devices. There is also appointed each month, by the Division Superintendent, a committee of three men from among the employees of each mine, known as the Mutuality Committee, who make a thorough inspection of all working places with a view to promoting safety conditions, as well as caring for mutuality features. In some mines we are now inaugurating a system whereby a section foreman will have charge of a certain part of the mine and will have not over twenty-five men directly under him, so that he can inspect all working places in his territory several times a day. The above system of inspection is, of course, supplemented by the regular visits of the gas men to all working places before the men are allowed to enter, also of the Mine Foreman and his assistant, the Division Superintendent and other officials.
3. Power and authority vested in the Inspectors.
Regular safety inspectors and all mine officials have the authority to take the necessary steps to remedy any immediate dangerous conditions and to stop the turn of miners who do not make their working places safe. Any recommendations for changes in practice of a general nature, or for safety work of any large extent, are submitted to the management. This latter applies also to the recommendations of the Mutuality Committee.
4. Some of the benefits derived.
(a) From standpoint of safety:
The benefits of the system from a safety standpoint are reflected in the number of fatal and serious accidents, which show a very decided decrease over the years previous to the organization of a thorough inspection.
(b) From standpoint of economy:
The decrease of fatal and serious accidents results in direct economy in the fewer number of damage suits filed and smaller number of claims to be paid through the Voluntary Relief Plan, and also effects

an economy in the fact that it necessitates fewer changes in the organization and gives one the benefit of the regular service of a larger percentage of employees, who might otherwise be off duty on account of injuries.

Pittsburgh-Buffalo Company
Operating Mines in Western Pennsylvania.

We have employed one private mine inspector for a little over 5 years; the mines which he had under his care having an output of about 2,000,000 tons annually. His orders were to take the mines in rotation, making a minute inspection of every working place of the mine, as well as the cages and machinery outside. The information which he obtained was embodied in a report to the General Manager unless dangerous conditions were discovered, in which case it was his duty to assist the Mine Foreman in correcting such trouble before proceeding further on his inspection, so that the only authority vested in the inspector was in case of emergency.

After making an inspection of the mine the inspector furnished the local management with a blue print showing the manner in which the mine was to be ventilated and no changes were allowed to be made in this method without his permission in writing.

In the Inspector's report to the General Manager he included suggestions along the lines of greater safety in operation; also more economical methods of recovering coal and of improving the routine system of the mine, which he also helped to standardize. Reports to the General Manager also showed the location of any loose material, rails caught under falls, or material out of place in the mine; the volume of air passing through the last breakthrough of all entries; and the conditions of air courses and ventilating machinery.

The benefits derived from this method of inspection were a check on the officials of the mines, the application of the good points in the management at one mine to all the mines and a thorough understanding by the operating official of the conditions existing at any one mine.

From the standpoint of economy, our inspection system prevented valuable supplies from being scattered around or lost in the mine, and helped to carry out our system of recovering supplies from finished workings and having a definite place to put them where they would next be needed.

The Consolidation Coal Company
Operating Mines in Western Pennsylvania, Maryland, West Virginia and Kentucky.

The Consolidation Coal Company has an inspection force (started October, 1909) entirely independent of the operating department of the Company, both as to personnel and duties prescribed. Covering some sixty mines in four districts (Pennsylvania, Maryland, West Virginia and

Kentucky) we have six inspectors who report to a Chief Mine Inspector located at Fairmont, W. Va. The Chief Mine Inspector reports to the Consulting Engineer, who in turn reports direct to the Executive Department, the idea of this arrangement being that the individual inspectors are entirely free from the operating department and can carry out their duties and make recommendations without fear of coercion or influence.

These inspectors have no power to direct the actual mining of coal but they do have power to stop work which in their opinion, is dangerous or to close a mine should, in their opinion, conditions warrant such action with the object of safety. These mine inspectors, however, in addition to their duties of examining working places, general practices and conditions, report such matters as come under their observation which would tend towards further economy. Their reports are in writing addressed to the Chief Mine Inspector who, after passing on them, writes a letter of recommendation to the manager of the division in which the report was made; copies of all correspondence pass to the office of the Consulting Engineer who may add to the recommendations should he see fit to do so.

In addition to these six inspectors there are two others who are known as Gas Inspectors, whose duties are to take samples and analyze them, periodically, of the return air of each split of such mines which produce gas in appreciable quantities. The Inspectors always report direct to the Chief Inspector.

As regards the benefit derived; this cannot be measured by any particular standard, but the object has been not only to discover dangers but to guard against those which are very common in coal mines; for instance, they will instruct a miner who apparently does not know the best way to make his place safe in the way of timbering or the placing of shots, the handling of powder, etc.

From the standpoint of economy we believe it to be a good investment from the fact that the inspectors are men of long experience and particular ability and can carry from mine to mine such methods as have proven best and educate the men to the use of such methods.

Their reports on the handling and preparation of coal inside the mine are a great help in directing particular attention to this very necessary part of the coal business.

We believe we have accomplished much in the education of miners and the adoption of standard methods by this inspection system and we are glad to say that the expected friction between the operating and inspection departments, due to such an arrangement, has not materialized to any extent and, as a whole, we believe the method is the best that has yet been suggested.

Utah Fuel Company
Operating Coal Mines in the State of Utah.

The Utah Fuel Company and its predecessor in interest, the Pleasant Valley Coal Company, commenced operations in Utah in 1879, the first

work being done at Winter Quarters, and then later the Castle Gate mines were opened. As mining progressed and the amount of underground development increased, a local inspection service was inaugurated. In the year 1889, on account of gas and the explosibility of mine dust in the dry Utah climate, the inspection service at Castle Gate was largely increased. That is, in addition to the mine foreman and local inspectors, a special inspector was put on. Experiments conducted by the Company led to the installation of the electric shot firing system, controlled from the exterior of the mine, and the partial installation of the present sprinkling system throughout Utah Fuel Company mines. This sprinkling system first consisted of a water line and nozzles for spraying water into the air on the intake air course, in conjunction with steam from the fan engine exhaust which was turned in during the night. These two features alone did not accomplish the desired result of thoroughly dampening the explosive mine dust, and the water lines were gradually extended until they were laid throughout the entire mine. Special connections were made for every room and crews kept continuously employed in sprinkling the mine. In this manner the entire underground workings were kept thoroughly damp in order to obviate the possibility of a small local explosion raising the dust and blowing up the entire mine. The electric shot firing system has been installed in all of our mines where gas is encountered.

At each individual mine the safety precautions and inspection are directly in charge of the Mine Superintendent. If large enough the mines are divided into districts with a mine foreman in charge of each district, and the area in charge of the mine foreman is subdivided into smaller districts which are in charge of the local inspectors who cover their respective districts daily. Where the electric shot firing system is installed there are special shot inspectors who have charge of all shooting in their given territories. The men acting as local inspectors are shot inspectors who have charge of all shooting in their given territories. The men acting as local inspectors and shot inspectors alternate as such so that the duties of these men are really both general mine inspection and shot inspection. The Utah Fuel Company also employs two general mine inspectors who thoroughly inspect the underground workings of all our mines once every two weeks.

In conjunction with the local mine inspection we maintain sets of Draeger rescue apparatus which are in charge of men thoroughly trained in rescue and first aid work.

The daily procedure on safety inspection at each mine is about as follows: The mine foreman checks the local inspectors' reports for the preceding night to see that no dangerous conditions are reported anywhere and that switches on shooting lines are open. He then notifies the checkman, who has a cabin stationed at or near the mouth of the manway of the mine, that everything is clear and that the miners can proceed to work. Each and every mine employee in the mine, no matter in what

capacity, is supplied with a check number and is checked into and out of the mine by the checkman. In this way it is absolutely known what, if any, men are underground when a shift goes off duty. The checkman at 5:30 P. M., or an hour and a half after shift goes off duty in the afternoon, notifies the shot inspectors whether the shooting can be commenced or not. In addition to checking the men in and out of the mine, the checkman at some of our mines supplies the men with their daily supply of powder, and where the shooting system is installed, supplies the shot inspectors with the necessary electric detonators. The shot inspectors go on duty at 1 P. M., each man being assigned to his regular district. They inspect all holes drilled in and issue the necessary electric detonators to the miners for firing these holes, provided they find same are properly drilled. After the miners leave the mine the shot inspectors, on receiving notification from the checkman that all men are out of the mine, and further by having the electric power cut off all power lines in the mine, commence at the most distant point in their territory to close the entry shooting switches, and then as they proceed out, close other principal shooting switches until the exterior of the mine is reached where the main shooting switch is located. This switch is on the 500-volt direct current power line, the switch being maintained in an open position and locked so it cannot be closed by any one other than the shot inspectors. The shot inspector unlocks the switch, closes the same momentarily, and then locks it into open position again. Momentary closing of the switch detonates every shot in the mine at the same time. The shot inspectors then return to the mine and throw open all shooting switches including the entry switches. They have then completed their shift's work and return to the check cabin where they report showing total number of shots fired in the mine, and further, sign a report showing that all shooting switches are open and disconnected from power lines.

The local inspectors then go on duty and inspect their given districts in the mine during the night. It is the duty of these men to inspect the entire ventilating system; to see that the airways, brattices, ventilating doors, etc., are in good shape; to test each and every room, all haulage ways, and return air courses for gas, bad roof, bad air, and insufficient supply of timber; to note whether timber is being maintained close enough to the face of all rooms to protect the miners; to note any defective track, misplaced material or material likely to be lost due to falls; to see that their district is properly sprinkled and no dry places in evidence; to see that the trolley wires and power lines are in good condition, and if not, to report same; to note with special care that the shooting system is in proper condition, and that all switches are open so that no stray current can get on to the shooting lines while miners are at work.

The mine foreman performs the regular duties assigned him under the Utah Law, and in addition thereto keeps close watch on the timbering

of the rooms and pillar workings. In coal mining it is very difficult to force miners to keep their places properly timbered.

Every conceivable reason and excuse that men can invent is made as to why timber should not be maintained within a short distance of the room or entry face. It is the practice of the mine foreman to warn men once or twice, and then if they do not comply with this regulation, to discharge them. This is especially necessary in Utah coal fields where seams are thick and the roof 12 to 14 feet away where a small fall of rock might result in very serious injury if not death. On account of the thickness of the Utah coal seams the accident rate does not make a favorable showing as the thorough safety precautions taken would seem to warrant when comparing Utah accident rates with those of eastern fields where the coal seams are much thinner.

It is difficult to specify what special safety benefits are derived from this work other than to say that the safety of all of the men employed and the mines themselves depend largely upon the character of service rendered by the local and general inspectors. Their work unquestionably prevents a great many serious accidents. Possibly the most valuable and most intangible asset connected with this work is the feeling of security and safety that the workmen themselves have on account of the thorough inspection made. In recent years two incipient fires were discovered which were taken care of quickly, thus no delay or property damage occurred. Either or both of these fires without proper inspection might have grown into very serious matters before they would have been discovered by the day shift. From the standpoint of economy there is a great deal of material recovered which might otherwise be lost; considerable tonnage of coal saved and mined which would probably have been lost; underground suggestions made as to more economical operation which are put into effect and make decided savings for the company. To sum the matter up, it is practically impossible to say in dollars and cents from either an economical or safety standpoint what the benefits are other than that they are greatly in excess of the cost of such inspection.

Pittsburgh Coal Company
Operating Mines in Western Pennsylvania.

Our first Company Inspector was put on April 1, 1901; since that time the service of inspectors has been increased until at present we have five.

Our mines are split into three divisions, each division under a Manager; two of these divisions have one inspector each, and the third division has two inspectors. Our fifth man, who has been with us the longest, is on in a consulting and advisory capacity.

The inspectors are under the direction of the mine managers, and report to them. Our inspectors have authority to order the immediate correction of anything that endangers life or property; beyond that they

are instructed to work in conjunction with the mine officials, first, looking to the safety of employees, and second, to the methods of working, organization of inside forces, and the general methods of safe and economic operation, our efforts being directed, as far as possible, to developing the local mine officials and inspectors into a unit of efficient mine management.

Our gain is that our inspectors are each familiar with the conditions of all of our mines, and are in position to make suggestions based on actual experience and observation, applying the good ideas of the local management of one mine to others where conditions will permit.

This applies not only to the safety but the economic standpoint as well.

Other replies could be given in whole or in abstract but they would be a repetition of the above in many respects.

Only in one instance has there been a question as to the economy as a result of the inspection service, whereas it is admitted there has been considerable gain from the standpoint of safety and in a reduction of the number of fatal and nonfatal accidents.

THE MINE WORKERS

The National and district officers of the miners' organization have given their moral support and in many instances have entered into close cooperation with movements for safety first, and safety first field meets have been promoted and conducted through the efforts of the district and local officers of the miners' organization, and the miner has shown his interest by becoming a member of local safety organizations, rescue and first aid teams. While the national organization has not taken the lead in furthering the safety first slogan in mines, it had voiced its approval of the safety work as conducted by the federal Bureau of Mines.

The miners in many states have contended that, while the inspection laws have improved conditions relating to safety, the chances of recovering damages for injury or death were made uncertain by reason of some provision of the law.

When miners feel that they are given protection for loss of time through injury and a fair and just compensation to their dependents in the event of death through accident, we

may look for their organization to become more active in demanding inspection laws which will call for greater safety, better sanitation in mining and the social welfare of the miner.

There is much that the miners could do through their organization to further the safety movement. In some quarters the progress of the safety movement has suffered and been held in check by the refusal of the organized men to give their coöperation and support. This lack of support is invariably due to a misconception of the main purpose of the safety movement.

Inspection by Miners.

In some localities the miners have coöperated in the inspection of mines by designating a committee of miners to accompany the state Inspector, but this practice has been only spasmodic since the members of the committee usually serve on the inspection tours without compensation.

However, in some localities where the operators pay the miners for the time spent in inspection work there has been much satisfaction on the part of the miners.

In the state of Kansas, for a number of years, the miners were authorized by law to select the state inspectors but under a recent law of this state the inspectors are appointed by the governor.

In the state of Ohio, the miners may appoint two of their number once every month to inspect the mine and machinery and report to the State Industrial Commission. The operator or two of his representatives may accompany these miners.

METAL MINING INSPECTION AND LAWS.

In a number of metal mining states there has been provided by law an Inspection service similar to the service in the Coal Mining States.

The work of the State and County Inspectors has been supplemented at a large number of mines through the organization of safety committees maintained by the operator.

Much benefit has resulted by the employment of company inspectors.

The comments on metal mining laws and the table giving the summary of inspection service in the metal mining states have been taken principally from the publications of the U. S. Bureau of Mines. Special acknowledgment is made to the authors of Bulletin 75*.

METAL MINING LAWS.

The laws pertaining to metal mining in the various states are deficient in many respects, viz:

(1) Fire prevention on surface and underground.
(2) Regulation of oils and inflammable materials.
(3) Regulation in storage and use of explosives.
(4) Overwinding devices.
(5) Record of inspections made at mines.
(6) Guard rails at collars of shafts and at levels and absence of protection at winzes.
(7) Boiler inspection.
(8) Stairways and auxiliary man hoists.
(9) Ventilation not specific in quantities.
(10) Sanitation, dry closets, drinking water, wash and change houses.
(11) Safety pillars surrounding shafts.
(12) Rules for safety.
(13) Code of signals not uniform except for starting and stopping and lowering; one signal being to start or stop, and two signals for lowering.
(14) Use of electricity; no regulation for voltage. Authors of bulletin on Metal Mine Regulations recommend low voltage under 300, medium voltage 300 to 650, high voltage over 650.
(15) Use of intoxicants.
(16) Smoking underground.
(17) Carrying matches.

There is lack of uniformity in salaries paid inspectors in metal mines in the United States, the chief inspectors receiv-

* Rules and Regulations for Metal Miners, by W. R. Ingalls and others,—U. S. Bureau of Mines Bulletin 75.

ing from $1000 to $3000 per annum, and deputies from $1000 to $1300.

The frequency of inspection as required by state laws ranges from once a year to once a month, the number of inspections being left largely to the judgment of the inspector who usually exceeds the requirements of the law two to four times.

The average cost of inspection of metal mines based upon the appropriations made by the states ranges from $16.50 in New York to $150 in Arizona, per mine inspected; and from $0.26 in Minnesota to $1.90 in Nevada, per man employed.

Arizona law of 1912 requires, where employing 25 or more men underground, to keep at least two fire fighting helmets in condition to be used and provide training in the use of same, tests to be made monthly by actual test.

Nevada law 1913, sec. 42-37: "Every mine employing forty or more men underground shall keep on hand in good working condition at least two smoke helmets of design to be approved by the inspector. An additional helmet shall be provided for each additional fifty men employed".

States having no metal mining laws: Alabama, California, Kansas, New Jersey, New Mexico, Oregon, Utah, Virginia, Washington and Wisconsin.

Inspection is provided for in connection with coal mine inspection in Tennessee and Oklahoma.

In North Carolina the Commissioner of Labor and Printing is inspector of Mines. No inspections are made since no appropriation is made for the work.

In Wyoming the State Geologist is *ex officio* inspector of metal mines.

In two states county inspection only is provided, Minnesota having three county inspectors and Michigan eight county inspectors.

States having metal mine inspection laws and systematic inspections are: Arizona, Colorado, Idaho, Missouri, Montana, Nevada, New York, South Dakota and Tennessee, and also the territory of Alaska.

Regarding methods of selecting mine inspectors in metal mining states, about half are elected and half appointed. The chief inspector appoints his deputies except in Oklahoma where they are elected. Where the chiefs are appointed the chief appoints his deputies except in Montana where the governor appoints both chief and deputies. This principle seems to be wrong; the chief should appoint his deputies since he is responsible for their work.

In metal mines there is no record of the conviction of a miner for violation of the safety regulations in this country. One would assume the laws and rules are either fully complied with or their enforcement neglected.